VACCINIA IN MAN

A CLINICAL STUDY

BY

THEODORE D. ACLAND, M.D.

Reprinted from "A System of Medicine," Edited by T. CLIFFORD ALLBUTT, M.D.

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PREFACE

THE following pages deal only with the clinical side of vaccinia and vaccination in man. The subject has been dealt with from the pathological point of view by Dr. Copeman, and as a question of state medicine by Mr. Ernest Hart, in the same volume of Dr. Clifford Allbutt's *System of Medicine* from which this article has been reprinted.

While these pages were passing through the press several valuable contributions to the study of the subject have appeared. Of these the most important are :—

1. *The Report of the Royal Commission on Vaccination, a Review of the Dissentients' Statement.* By T. C. McVail, M.D. (Read before the Epidemiological Society, 19th February 1897.)
2. "Some Small-pox Statistics." By Sydney Coupland, M.D. *Lancet*, 1897, vol. i. pp. 510 and 582.
3. *English Vaccination and Small-pox Statistics, with special reference to the Report of the Royal Commission, and to recent Small-pox Epidemics.* By Noel A. Humphreys. (Read before the Statistical Society, 19th February 1897.)
4. Mr. Picton in the *Contemporary Review*, 1896, and Mr. Malcolm Morris in the *Nineteenth Century*, 1896, have discussed the conclusions of the Royal Commission on Vaccination from opposite points of view.

Dr. McVail's paper exposes the weakness of the position taken up by Mr. Picton and Dr. Collins in their dissent from the final report of the R.C.V., and up to the present time no attempt has been made to reply to it.

In Dr. Coupland's record of his investigations into the outbreaks of small-pox at Gloucester, Dewsbury, and Leicester, the question of the protective influence of vaccination is discussed. His observations were conducted with every safeguard against error, and the facts and conclusions which have been recorded in an admirable and convincing manner will repay careful study.

T. D. A.

March, 1897.

VACCINIA IN MAN—A CLINICAL STUDY

By T. D. ACLAND

VACCINIA IN MAN—A CLINICAL STUDY

Part I

Vaccinia Normal and Abnormal

Introduction.—Vaccinia in man is a communicable disorder arising, except in very rare instances, from the accidental or intentional inoculation of an individual with vaccine lymph. The disease is probably due to a specific contagium (9). It has definite periods of incubation, evolution, and decline; and is characterised by an eruption at the point of inoculation, which eruption has certain well-recognised features.

It is improbable that any more precise definition of vaccinia will be possible, until its origin and affinities are more fully determined than at present. Nor is there anything surprising in this, since similar general definitions have to suffice for all the acute exanthems—such as variola and scarlet fever—the recognition of which depends rather on a given train of symptoms, than on a precise knowledge of the causation of the malady.

In the following pages the expression "vaccinia in man" is taken to denote the sum of the results produced by the inoculation of uncontaminated vaccine lymph, as generally practised throughout the United Kingdom.

The course of vaccinia may be normal or abnormal. It may be called normal when the events, subsequent to vaccination, pursue a cer-

[1] In the following pages frequent reference is made to the various reports and appendices issued by the Royal Commission on Vaccination between 1889 and 1896. To save repetition these volumes are referred to as R.C.V. Final Report; R.C.V. Appendix ix., etc.; the latter contains the papers relating to cases in which "injury or death was alleged or suggested to have been caused by vaccination, or to have been connected with it." Of these cases 205 were inquired into by the medical staff of the Local Government Board, and the abstracts of these reports were prepared for the Commission by Dr. Coupland and myself. Besides these, 421 additional cases were brought to the notice of the Commission; and most of them were investigated by Dr. Barlow, Dr. Coupland, Dr. Luff, and myself. These inquiries extended over a period of seven and a half years; that is, from November 1888 to April 1896. The writer is greatly indebted to those who, often at much personal inconvenience, have given him assistance in investigations which were, in some instances, necessarily prolonged; and he wishes to take this opportunity of acknowledging the help which has been given him, both by the supporters and opponents of vaccination, without which help many of the investigations would have been impossible.

tain definite and recognised sequence. The gradations, however, between normal and abnormal vaccination are insensible, and no hard and fast line can be drawn between them; although between the cases which occur at either end of the scale there are wide and striking differences.

Normal vaccination results from the inoculation of a healthy individual with vaccine lymph uncontaminated with extraneous micro-organisms, or other organised or unorganised products, which, although not infrequently present, are not, so far as is known, in any way essential to the process of vaccination or to the production of immunity from small-pox. Under existing circumstances, it may not be possible, as a rule, to collect lymph entirely free from extraneous organisms (44); but even if this be so, healthy tissues are to a certain extent refractory, and no evil result is to be feared unless the dose of extraneous organisms be sufficient to overcome their resistance. This power of resistance, however, is not the same in all cases, and this variation may probably account for the fact which is sometimes observed; namely, that one or more individuals of a series inoculated with the same lymph, develop inflammatory symptoms—such as cellulitis, abscess, or even possibly erysipelas—whilst in others of the same series vaccination pursues a normal course.

It is sometimes urged against vaccination, that it is impossible by examination of the lymph to determine with certainty what results will be obtained. This objection has some weight, since no ordinary microscopical examination of lymph stored in tubes, will reveal pathogenetic or pyogenetic organisms; and it is doubtful whether lymph, collected in the ordinary way, does not always contain blood corpuscles. The force of the objection is, however, more apparent than real; experience shows that lymph taken from normal vesicles in healthy individuals produces certain definite results in healthy and properly cared for infants; while on the other hand no selection of lymph will remove dangers which arise from the method of vaccination, the circumstances or condition of the child, or the improper treatment of the vesicles: all which factors are found to be far more productive of untoward results than any defect in the quality of the lymph itself.

Normal vaccination.—Under favourable conditions vaccination is followed by local manifestations and general symptoms which, within certain limits, vary according to the strength of the virus used, and the peculiarities and circumstances of the individual. The local manifestations are so well known as to need but the briefest mention.

Period of incubation.—In most cases the immediate effect of the operation is nothing more than that which results from a scratch; but in some children of unusual susceptibility, there is immediate evidence of some slight traumatic reaction, such as swelling and redness of the part, which in the course of a few hours entirely subsides until the end of the incubation period. This stage lasts as a rule for about three days.

Period of eruption. — On the 3rd or 4th day, pale red papules develop at the points of inoculation which, in the course of the next five days, develop into compound vesicles with clear contents, and later, about the 10th day, into pustules; the lymph becoming more and more opaque owing to the multiplication of the cellular elements which it contains. The vesicles are at first fully distended and plump; as they approach maturity they become umbilicated, the centre begins to dry, and a scab is formed which increases towards the periphery, and eventually covers the whole pock. Between the 14th and 20th days the scab falls off, leaving a scar which, dusky red at first, gradually, after some months, becomes white and pitted (foveated). The amount of pitting as a rule varies inversely as the amount of inflammation which has occurred at or round the seat of inoculation (for a further account of abnormal conditions of the scar, see p. 8).

About the 5th day, when the vesicles are beginning to form, a faint blush appears round them. This "areola" becomes more intense about the 9th or 10th day, gradually subsiding with the drying-up of the pocks, which begins about the 11th day. The areola extends from $\frac{1}{4}$ inch to 2 inches round the pocks, the tissues becoming indurated and painful in proportion to the severity of the inflammation.

This areola, formerly supposed to be an important part of vaccination, varies greatly in intensity, and probably is largely dependent on the kind of lymph used and the method of preserving it. (The alleged relations of the areola to erysipelas will be found discussed on p. 34.)

With the retrogression of the pock and the subsidence of the areola the local phenomena of a normal vaccination are at an end.

Variations in the development of the vesicles.—Although under ordinary circumstances the development of the vaccine pocks proceeds in the manner sketched above, there are frequent departures from the normal course, most of which are of little or no importance; many depend on the condition of the vaccinee and his circumstances, some on causes quite independent of vaccination and easily preventable. No useful purpose would be served by giving details of all the variations from a definitely regular development of the vesicles; but the following table indicates the kind of irregularities which are met with from time to time :—

TABLE showing variations in the development of vaccine pocks.

a. Variations in number . . .	Supernumerary pocks. Confluent pocks round points of inoculation. Generalised vaccinia.
b. Variations in size	Due to coalescence of vaccination vesicles. Due to extension of original vesicles by coalescence of surrounding secondary pocks.

c. Variations in contents . . .	Watery. Purulent. Hæmorrhagic.
d. Variations in evolution . . .	Acceleration. Retardation. Abortion. Recrudescence. Persistence.
e. Variations in involution . .	Inflammation. Suppuration. Ulceration. Gangrene.
f. Variations in healing and formation of scar.	Delayed healing. Induration. Keloid.

a. Variations in number.—This subject, which is necessarily of some length, will be more conveniently considered under the heading of generalised vaccinia (*q.v.* p. 15).

b. Variations in size.—Two, three, or four of the compound vesicles resulting from ordinary vaccination, may coalesce to form one large pock, the size of which may be almost indefinitely increased by the development of supernumerary pocks in the immediate neighbourhood of the primary vesicles; an example has been recorded by myself (1) in which the sore on the arm thus produced measured 4 inches by $4\frac{1}{2}$ inches.

These cases as a rule are not serious; with cleanliness and protection of the arm from injury, the sores heal well and quickly.

c. Variations in contents.—Under certain conditions, the most important of which are a cachectic state of the vaccinated child, the use of contaminated lymph, or the improper treatment of the vesicles (*vide* Vaccinal Ulceration, p. 60), the contents of the pocks, instead of being clear and bright at the end of the first week, may be watery and unhealthy, or pus may have formed early, or the contents of the vesicles may be hæmorrhagic: any one of these conditions may be of grave importance.

d. Variations in evolution.—(i.) The development of the pocks may be accelerated by the season of the year—it is more rapid in warm weather than in cold—it is influenced by the idiosyncrasy of the individual, and also by the amount and activity of the lymph used. Their development is also accelerated by the degree of immunity which has been attained by previous vaccinations. Thus Cory (9*a*) found by vaccinating in series, one insertion being made on each of eleven successive days, that all the successful insertions came to maturity on the ninth day. The insertions made subsequent to this date were ineffectual. He also found (9*b*) that in cases in which vaccination was performed on supernumerary fingers which were removed on the fifth day, vaccination performed in the usual way a month later hurried through its cycle, as happens in the revaccination of individuals in whom immunity has not been completely secured.

(ii.) Retardation of the pocks may be brought about by the converse of such conditions, the evolution of vesicles being delayed for ten, fifteen, or possibly even thirty days (37*a*); and some cases have occurred in which vesicles which seemed to have aborted entirely were excited to activity by a revaccination a week or more after the first insertions.

(iii.) The recrudescence of a pock and its breaking down after an interval of some weeks has been noted in cases of invaccinated syphilis (p. 62), and should at any rate excite suspicion as to the purity of the lymph. No allusion is here made to those cases of ulceration of pocks which not infrequently result from some mechanical injury to the scabs.

(iv.) The non-development or abortion of pocks at the points of vaccination probably depends largely on the quality of the lymph and the experience of the vaccinator. The "insertion-success" of skilled vaccinators is very large, amounting to 97-98 per cent.

e. Variations in involution.—As has been observed above, a hard and fast line cannot always be drawn between the local manifestations which result from vaccination in a normal case, and those which so far exceed what is necessary or desirable, as to constitute a source of danger to the individual vaccinated. As regards the vesicles it will be found, that besides those departures from the normal which have been indicated above, many of which may be considered as of little consequence, complications such as severe inflammation round the pocks, ulceration, coalescence of several pocks into one large ulcer, and even local necrosis of the tissues in the region of the pocks, may occasionally occur. Abnormal results in vaccination depend on so many factors—the lymph, the method of vaccination, the treatment of the vesicles, the condition of the individual vaccinated, both previous and subsequent to the operation—that it may be by no means easy in a given case to trace their origin, to detect the cause, or to predict their occurrence; such results may however be expected to follow the careless treatment and injury of the vesicles, the vaccination of feeble or sickly children, lack of care, and unsuitable feeding of children during the vaccination period, or the use of lymph which has been improperly stored, or collected from vesicles with obvious inflammation about them. A further cause of danger possibly lies in the vaccination of children who have recently been exposed to, or who are incubating, some acute disease, such as scarlet fever or measles. This enumeration might be prolonged, but these examples will serve to show that a large number of the inflammatory complications which follow vaccination are directly traceable to some extraneous cause, and cannot in any way be considered merely as variations in the involution of the normal vaccine pock. The cases of suppuration, ulceration, and gangrene are, however, of so much importance that they will be considered under the heading of Vaccinal Injuries (p. 31).

f. Variations in healing and formation of scar.—Vaccination wounds,

under normal conditions, should be well and firmly healed before the end of the third week; but in rare cases they may remain open for many weeks, or in still rarer instances, for months. This delay in healing is often due to easily preventable causes, such as repeated injury to the scabs—by other children, by shields, dirty sleeves, dirty applications—and general want of cleanliness; sometimes it is due to the feeble condition of the child combined with unfavourable surroundings: and, though no doubt in exceptional cases the ulceration is definitely started by vaccination, in most of the instances which have come under my own notice I have found that extraneous conditions are, as a rule, far more to blame for prolonged ulceration than any inherent defect in the lymph or in the method of vaccinating. Such cases of deferred healing are not infrequently mistaken for vaccinal syphilis; and a protracted investigation into a series of such cases, which was made by Dr. Barlow and myself, will be found in App. ix. to Final Report of R.C.V. 1896, pp. 320-329. The means by which a diagnosis may, in most cases, be made with certainty will be found in a later section under the head of Vaccinal Syphilis (p. 62).

Although, as already indicated, the scar left by vaccination conforms, as a rule, to a general type, its appearance may present very considerable variations. There is nothing peculiar to vaccination in these abnormalities; they depend largely on the amount of inflammatory reaction at the seat of inoculation. The changes which are most frequently met with are simple hypertrophy or puckering of the scar, and keloid. None of these conditions indicate that the operation has been unsuccessful; and no certain deduction as to the course of vaccination can be made from them. I have seen a case of keloid, for instance, which followed on vaccination made by subcutaneous punctures in which no true vesicles resulted; and Mr. Hutchinson has recorded a case which followed after protracted ulceration of the pocks (28). There is some ground for supposing that the occurrence of keloid depends on the idiosyncrasy of the person, since there is not only a tendency for the condition to spread beyond the limits of the original scar, but, if removed, it tends to recur (23*a*).

Lupus of the vaccination scars is discussed under Invaccinated Tubercle, p. 622.

General symptoms.—These are commonly unimportant; sometimes a slight rise of temperature is noted about the 3rd day after inoculation: this may be followed by remissions, and the pyrexia, if any occur, reaches its maximum generally before the 8th day. These slight disturbances are often the only evidence of a general diffusion of the virus, although eruptions such as erythema, roseola, or urticaria may accompany even the mildest and most favourable cases of vaccination. These rashes, which may develop early in children who are unusually susceptible[1] to the vaccine virus, may occur within four or five days

[1] The problem is generally thus stated, and although children differ widely in their reaction to all kinds of external stimuli, increased susceptibility to the vaccine virus must in

of inoculation, or they may develop during the period of maturity and subsidence of the pocks; they have no special significance, and, as a rule, are not harmful except in so far as they produce irritation and consequent restlessness. Amongst the more usual complications which occur at or about the period of the full development of the pocks are those which are common in all the acute exanthems: they consist in headache (in adults and in elder children), lassitude, irritability, sleeplessness, disturbances of the digestive system—such as anorexia, vomiting, catarrhal diarrhœa; and possibly, during the onset of the vaccinal fever, rigors may occur in adults and in the revaccinated, and convulsions in infants. In relation to these indications of a general infection in some instances there will be evidence of a corresponding disturbance of the circulatory or respiratory apparatus, as shown by increased rapidity of pulse and respiration, bronchial catarrh, or slight temporary albuminuria.

Fürst (23) calls attention to the fact that an increase occurs in the number of leucocytes in the blood during the vaccination period. This increase takes place about the 3rd day, when the local eruption is first developing; and again when the surrounding inflammation is at its height. The leucocytosis diminishes rapidly with the fall of temperature in the early part of the second week, and appears to be proportional to the severity of the symptoms.

Part II

Vaccinal Eruptions and Complications

Introduction.—Before taking up the general question of vaccinal injuries, attention may be directed to some of the more usual complications which are met with after vaccination: of these the most obvious are the cutaneous eruptions which, although they frequently accompany and sometimes result directly from the inoculation of vaccine lymph, yet for the most part are not peculiar to vaccination, but are common both in infants and adults, and arise from the most diverse causes.

The fact that eruptions of various kinds follow vaccination is now generally recognised. They are as a rule harmless and of simple well-known forms, such as occur in all persons, especially in the very young, under the influence of irritants of widely different kinds and acting in various ways. The rashes produced by belladonna, potassium iodide, mussels, hydatids, septic infections, and antitoxins are familiar to all of us; many of the vaccinal eruptions, however much they may differ in the strictly pathological sense, are clinically of the same kind, and are probably due to a similar cause. Some of them have obtained a fictitious importance in view of the suggestion that an analogy exists between syphilis and

our present state of knowledge be held only to imply that the effect produced by vaccination is unusually severe, since there is no method available for standardising the strength of any particular lymph: so that one child may receive a much stronger dose than another, and the apparent greater susceptibility of one child over another may possibly mean only that he has received a larger dose of the virus.

vaccinia, on the ground that amongst other symptoms roseolous and other eruptions are common to both. The suggestion is of little value when it is remembered that like eruptions are common after infection by diseases differing as widely as variola and cholera.

From such data as are available it seems probable that these rashes, which are by no means peculiar to, or characteristic of vaccinia, signify only that a generalisation of the virus has taken place as the result of the local inoculation; and, further, it seems reasonable to conjecture that they are excited by some chemical irritant, as distinguished from those which, like erysipelas, are due to micro-organisms.

Vaccinal eruptions are usually characterised by their temporary duration and irregular distribution, and by their concurrence with vaccination; they are often attended with much irritation, considerable general disturbance, and some pyrexia.

All kinds of eruptions occurring after vaccination are not infrequently attributed to it; for instance scabies, acne, or even the rash produced by potassium bromide administered medicinally. A case of the latter kind came under the care of Dr. T. C. Fox.[1] A mother who was suckling her child suffered from epilepsy, for which she was taking large doses of potassium bromide: the infant after vaccination suffered from a plentiful crop of bromide pustules, which disappeared immediately on suppression of the drug.

In making the diagnosis of a vaccinal eruption it is necessary to bear in mind these possibilities of error, which may easily excite unnecessary alarm or suspicion in the minds of those who are responsible for the care of recently vaccinated children.

Classification and Chronology. — Various classifications of these eruptions have been made, of which the most satisfactory are those given by Drs. Malcolm Morris and Crocker, to whose works I am much indebted (42, 11*a*).

CLASSIFICATION OF ERUPTIONS AND OTHER COMPLICATIONS FOLLOWING VACCINATION

Eruptions peculiar to vaccination.

1. Those which may result from the inoculation of uncontaminated vaccine lymph :—
   (*a*) Multiplication of vaccine vesicles by diffusion through digestive, circulatory, or other systems—generalised vaccinia.
   (*b*) Multiplication of vaccine vesicles by auto-inoculation.
2. Those probably due to some contamination of the lymph or to some peculiarity on the part of the individual vaccinated—vaccinia gangrenosa; vaccinia hæmorrhagica.

Eruptions not peculiar to vaccination, and which may be excited by the absorption of many kinds of virus; probably due to chemical irritation, not to microbic infection.

[1] *British Journal of Dermatology*, 1892, vol. ii. p. 287. A drawing of a similar eruption alleged to be vaccinal is given in the report of the Medical Officer of the Local Government Board, 1888, p. 28.

1. Urticaria; Lichen urticatus.
2. Erythema multiforme.
3. Roseolous, papular, vesicular, pustular, bullous eruptions (11, 37).
4. Eruptions resembling those of measles and scarlet fever.

Complications not peculiar to vaccination, which may result from the infection of any wound, and are due to some peculiarity on the part of the individual vaccinated, or to the introduction of some extraneous virus into the wounds at the time of vaccination or subsequently.

1. Probably due to peculiarities of the individual: Eczema; Psoriasis; Pemphigus; Local Gangrene.
2. Probably due to some microbic infection of the wounds: Impetigo contagiosa; Tinea tonsurans; Furunculosis; Glandular abscess; Cellulitis; Erysipelas; Septic infections; Tetanus.
3. Causation doubtful; possibly due to microbic infection: Purpura.

Inoculated diseases.

Syphilis; Lupus? Tuberculosis? Leprosy? Cancer? Epizootic disease?

The dates at which these eruptions or complications may be looked for after vaccination are as follows:

1. During the first three days: Erythema; Urticaria; Vesicular and bullous eruptions; Invaccinated erysipelas.
2. After the third day and until the pock reaches maturity: Urticaria; Lichen urticatus; Erythema multiforme; Accidental erysipelas.
3. About the end of the first week, and generally after the maturation of the pocks: Generalised vaccinia—(*a*) by auto-inoculation, (*b*) by general infection; Impetigo; Accidental erysipelas; Vaccinal ulceration; Glandular abscess; Septic infections; Gangrene.
4. After the involution of the pocks: invaccinated diseases, for example syphilis.

The dates at which the various eruptions or complications of vaccination appear after the operation is a matter of considerable importance, as showing the true nature of those cases in which the suspicion of invaccinated syphilis has been raised; and this is especially important since more than one recent writer has endeavoured to trace analogies between vaccinia and syphilis. Thus Creighton (10) states that "the real affinity of cow-pox is not to small-pox, but to the great pox. . . The vaccinal roseola is not only very like the syphilitic roseola, but it means the same sort of thing."

It may be pointed out that the vaccinal roseola appears within a week of inoculation, syphilitic roseola not, as a rule, for a month; that roseolous and erythematous rashes are common prodroma of small-pox, and occur very frequently after the injection of antitoxins—

diphtheritic and others; and again that the date of their appearance and the absence of any distinctive characteristic are opposed to the deduction that they are in any way allied to syphilis.

There does not seem to be adequate ground for concluding that, with the exception of generalised vaccinia, any of the eruptions enumerated above are peculiar to vaccination, or are an essential part of it. Their occurrence in a small number of cases is undoubted; in some instances they certainly depend on extraneous and therefore removable causes, and in others they depend on peculiarities in the individual which are often unsuspected at the time of operation, and cannot be foreseen.

Nothing would be gained by discussing in detail all the various forms of eruption which may follow vaccination. None of them has any peculiar significance in vaccination; many of them are unimportant, and are only mentioned because they are sometimes a cause of anxiety to

FIG. 1.—Supernumerary vesicles. Stage i. Discrete. Drawing made on 9th day after vaccination with lymph, 46th remove from the calf, and 4th remove from H. T. (*vide* Fig. 5, p. 16). For details, see Case 214, Appendix ix. to Final Report R.C.V., p. 402, No. 500.

those who are unacquainted with their harmless character. The more important eruptions, and some of the more troublesome,—such as eczema, impetigo, herpes,—require further notice; erysipelas, syphilis, tubercle, and leprosy, etc., will be considered later in detail.

From a clinical point of view the eruptions peculiar to vaccination are without doubt the most interesting and important; for if there be any connection between vaccinia and variola, it might be expected that cases would occur from time to time in which the symptoms following vaccination would more closely resemble inoculated variola than the merely local phenomena which are generally associated with vaccination. Such cases do in fact occur; and, though the instances are rare in which vaccination is followed by a general eruption of pocks like those at the point of inoculation, it is (judging from my own experience) by no means very uncommon to find the original insertions surrounded by supernumerary pustules, cf. Figs. 1, 2, 3, so that the appearances closely resemble the drawings of inoculated small-pox by Kirtland, reproduced in the *British Medical*

Journal, vol. i. 1896, p. 1276. I do not intend to maintain that this resemblance implies of necessity any community of nature between variola

Fig. 2. Supernumerary vesicles. Stage ii. Semi-confluent. Drawing made on 14th day after vaccination with humanised lymph.

and vaccinia, possible as this may be for reasons which are discussed by Dr. Copeman (*System of Medicine*, vol. ii. p. 638), but it is certain

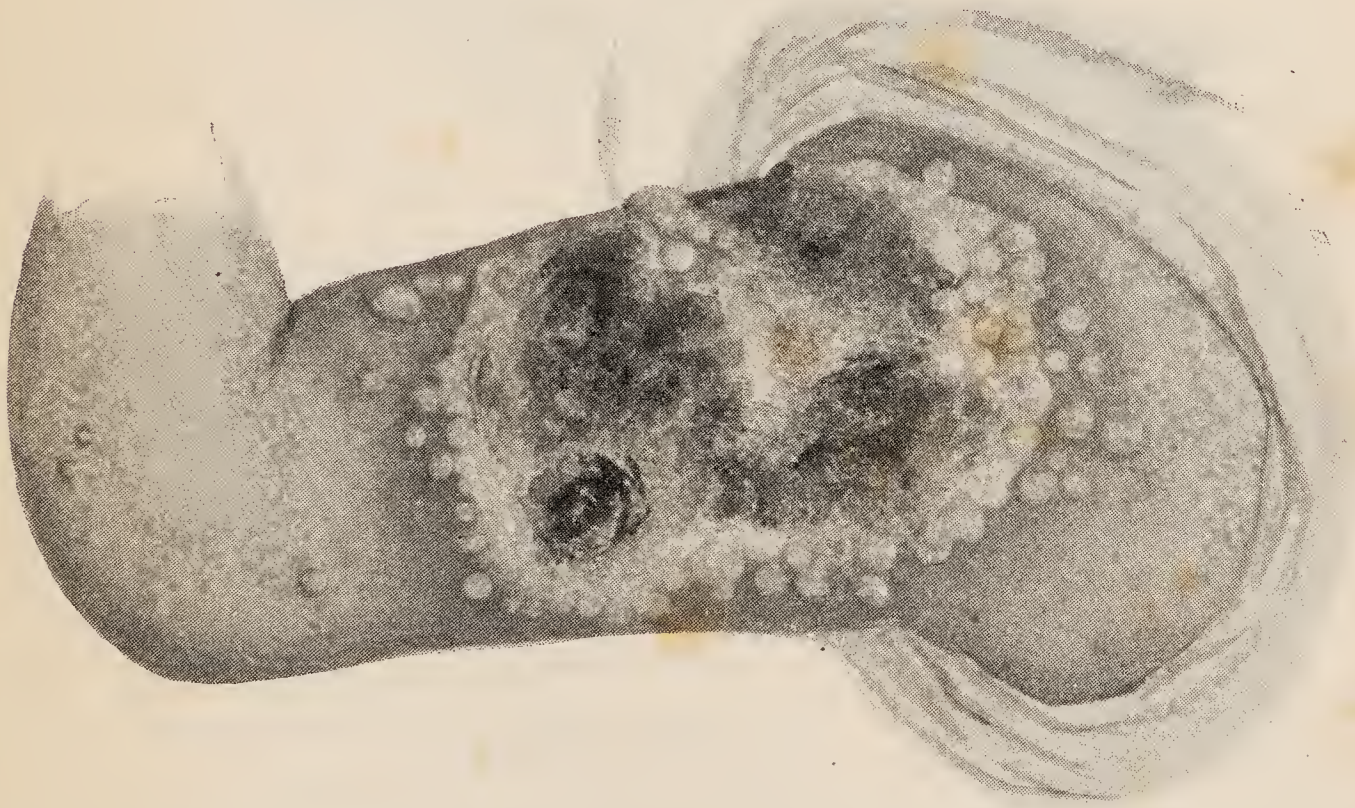

Fig. 3.—Supernumerary vesicles. Stage iii. Confluent. Drawing made on 16th day after vaccination in four places with humanised lymph. First appearance of eruption on 9th day; eruption first confluent on 11th day. Besides the eruption on arm there was only one umbilicated vesicle on abdomen. Compare with Fig. 4, showing inoculated small-pox, and Fig. 5, vaccinia confluent at point of inoculation in a later stage.

that, under certain conditions, the course of vaccinia departs from that which is ordinarily observed, and the affection becomes comparable to

one of the exanthems, instead of being characterised only by a local pock without any general eruption. It is also worthy of note that conversely small-pox, by successive re-inoculations of the same individual, may show itself only as a local pock at the point of inoculation without any general eruption (43, 49). This is the case not only in the direct inoculation of variolous lymph, but is equally so in "vaccinations" performed with lymph taken from pocks raised on the calf by the inoculation of small-pox virus. These points of resemblance between variola and vaccinia are of interest whether they indicate any close relationship between the two affections or not; there is little warrant, indeed, for the belief that generalised vaccinia is identical with variola: and, so far as I am aware, no case has been recorded in which vaccinia has

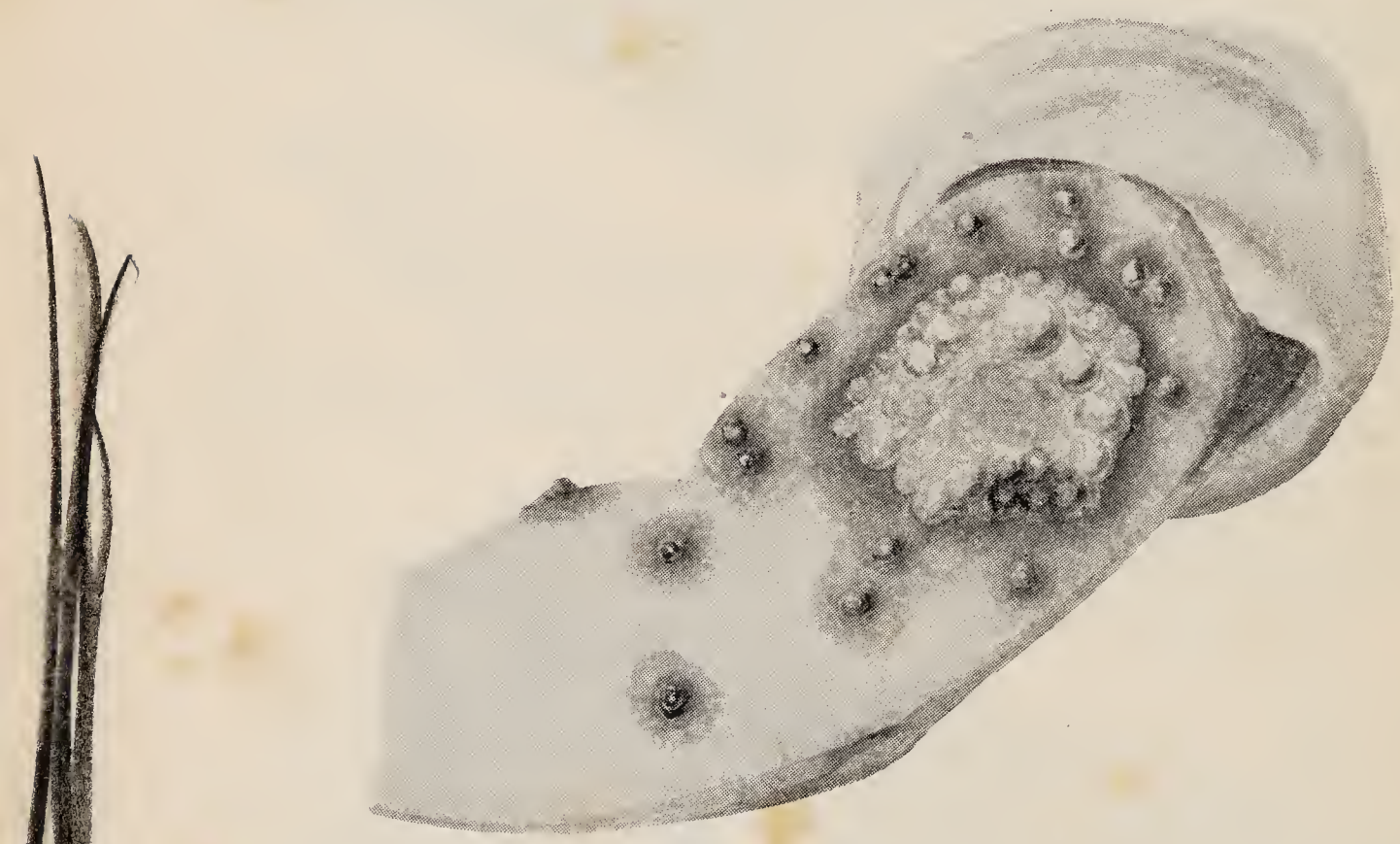

FIG. 4.—Inoculated small-pox. Showing the appearances of a single insertion on the 14th day. From the original drawing by G. Kirtland (1802), lent by Mr. G. W. Collins of Wanstead.

proved to be communicable, except by inoculation, without actual contact with the person infected as is the case in small-pox.

Generalised vaccinia differs in many ways from a general diffusion of vaccine pocks by auto-inoculation through the skin; though both affections indiscriminately have been called by the same name. For convenience of description Longet's classification of these generalised vaccinal eruptions may be adopted. It is as follows :—

1. Spontaneous general vaccinal eruptions or generalised vaccinia —Vaccinal eruptive fever.

2. Vaccinal eruptions generalised by auto-inoculation, for example, by scratching—(without any pre-existing lesion of the skin. T. D. A.) Multiplication of pocks by auto-inoculation.

3. To these should be added local vaccinal eruptions (often con-

fluent) the occurrence and position of which are determined by some pre-existing cutaneous lesion such as impetigo, eczema, acne, or psoriasis. Some inevitable confusion has been caused by not clearly discriminating between vaccinal eruptions which have occurred on surfaces previously sound, and those in which the seat of the eruption has been determined by some previous local affection.

4. Vaccinal eruptions by migration.

These are too rare to be of any practical importance since they consist of those cases of generalised vaccinia in which the general eruption is the primary manifestation, no local result having followed at the point of inoculation. (Longet, *loc. cit.* p. 205.)

Generalised vaccinia, or vaccinal eruptive fever, occurs, as a rule, comparatively early after vaccination; either one or two days before or one or two days after the pock at the seat of inoculation has arrived at maturity, that is to say, not generally before the 4th day or after the 10th. The date of its appearance may however vary considerably. In Poole's case (App. ix. R.C.V. No. cxciv. p. 70) the eruption began on the 13th or the 14th day (46); in Fox's two cases on the 9th day. The pocks form in successive crops, so that at a given date they may be found in all stages of development; in the three cases alluded to, the eruption continued to appear from the 13th to the 28th day, from the 9th to the 19th, and 9th to the 16th days respectively. When it first appears the eruption is dusky red and rapidly becomes papular, vesicular, and finally pustular; in two or three days the pocks arrive at maturity, and sometimes closely resemble the original vaccine vesicles: in other cases they so much resemble those of variola, that Bousquet declares that there is "so much resemblance between vaccinia and inoculated variola that no physician, however experienced, is in a position to differentiate the vaccinal from the variolous pustule. The most sagacious make mistakes. In a word, at whatever period you select—the 7th, the 10th, the 12th, or 15th day—the characters of the one are the characters of the other. There is no difference between them"[1] (Fig. 4). This is hardly the case, since the eruption of inoculated variola usually appears about the 12th (9th-14th) day. Generalised vaccinia, as a rule, appears earlier (about the 7th day); and the vaccinal fever is generally less pronounced and the constitutional disturbance less marked than in the case of variola. It is not usual for the vaccinal

[1] An interesting case is reported by Dr. Sharkey (52), "A case in proof of the non-identity of variola and varicella." In this instance, a boy who may have been exposed to the contagion of small-pox (though this is not certain) was admitted to St. Thomas's Hospital suffering from varicella. He was vaccinated, and eight days afterwards an eruption believed to be small-pox began to make its appearance. If generalised vaccinia can be determined by a cutaneous eruption, it is conceivable that this was in fact a case of that disease; and in this connection attention may be called to a remark of Dr. W. T. Simpson, whose researches into the relation of variola and vaccinia are well known (53):—"Vaccine and chicken-pox have always seemed to me to be two elements of small-pox which have become separated in some unknown way; the vaccine retaining the peculiar qualities which affect the body in such a manner as to render it immune from a second attack, while chicken-pox has none of these qualities."

eruption to be found on the mucous membranes or conjunctivæ; but this distinction does not hold good in all cases. Two instances in which the mucous membrane of the mouth was affected, and one in which the vesicles formed on the conjunctivæ, have recently been noted in England. (See L.G.B. Reports, Nos. li. and clxii. App. ix. to Final Report of

Fig. 5.—Vaccinia confluent at point of inoculation, showing the ulcerated surface left after removal of the scabs. There are two supernumerary pocks on forearm. The drawing was made 43 days after vaccination. For details of case see p. 23; also Case 214, Appendix ix. to Final Report R.C.V., p. 402. Figs. 6 and 7 are from the same case.

R.C.V. 1896, pp. 20 and 56.) The similarity of the two affections is such that the suspicion of variola was raised in not a few of the recorded cases before the nature of the eruption was recognised (27, 29, 40*a*, 41, 46).

The following table, founded on that given by Dauchez, gives the chief points of difference between variola, inoculated variola, and generalised vaccinia—eruptive vaccinal fever:

Day.	Variola (33).	Inoculated Variola (57, 34).	Vaccinal eruptive Fever (Generalised Vaccinia).
1.	Contagion.	Inoculation.	Vaccination.
3.	Period of incubation.	Papule at point of insertion becoming vesicular: vesicle prominent, slightly umbilicated.	Papule at point of insertion becoming vesicular. Supernumerary vesicles form between 3rd and 9th days.
7.	,,	The local pock fully developed by the 7th day.[1]	7th-8th day slight pyrexia.
9. 10. 11.	Malaise, rigors, pain in back, vomiting, reddening and enlargement of glands.	Inflammatory areolæ 10-15 pustules form round points of inoculation; headache, vomiting, pain in back, slight fever.	Maximum of development of pustules, which gradually decrease until the 16th or 17th day.
12.	...	Between the 11th and 13th days the specific eruption of variola appears generally discrete and resembles varioloid.	
13.	Erythematous or roseolous eruptions followed by specific papular eruption on face, wrists, flexor surfaces of arms, etc.	...	The extent of febrile reaction seems to depend on the extent and nature (discrete or confluent) of the eruption, as well as on unessential complications such as ulceration of pocks, excessive local reaction, etc.
15.	Remission of fever.	...	Besnier considers that there is no pyrexia unless there be some complication, for example, glandular enlargement.
17.	Papules become vesicular and umbilicated.	...	Subsidence of eruption generally complete before 21st day.
20 to 22.	Eruption becoming pustular. Secondary fever.		
	The exanthem is contagious.	The exanthem is contagious.	The exanthem is only communicable by direct inoculation of one individual from another.

[1] The local eruption of inoculated variola is not complete until the 7th day, according to Rayer (47); the general eruption developing from this date, but not being complete until the 13th or 14th day.

The only decisive test whether an eruption following vaccination be a true "vaccinide" or not, is that lymph taken from one of the vesicles

at a distance from the original point of inoculation shall be capable of reproducing the specific effects of vaccination in an animal, or in another child (19). That this can be done has been shown by Richard and by Martin. In the former case 15 children were successfully vaccinated; and in Martin's case a heifer was successfully vaccinated from pocks which developed in a child suffering from a general eruption, resulting, as it would appear, from its being suckled by its mother during the period of her vaccination. An interesting demonstration of the true nature of the supernumerary pocks was given in a case of vaccinia generalised by auto-inoculation, reported by myself (1), in which the child suffering from pocks on its lips and face inoculated its mother's breast; the subsequent vesicle showed no departure from the ordinary appearances or evolution of a vaccine pock.

Causation of generalised vaccinia. — Apart from any peculiarity of the lymph, and without assuming abnormal receptivity on the part of the individual, the eruption of vaccination may cease to be purely local if the virus is administered, not through the skin, but by the digestive, circulatory, or respiratory systems; and also (apart from auto-inoculation, which is considered later) if during the vaccination period there is some coexistent, general cutaneous eruption, such as sudamina.

A generalised vaccinial eruption has been produced in children who had sucked their vaccination pocks;[1] and it has been determined in those who had previously proved insusceptible to vaccination, by the intentional administration of powdered vaccine crusts (7). Similarly, as has been noted, a general vaccinal exanthem has appeared in a child suckled by its mother whilst undergoing vaccination (41).

It is of interest in connection with this case to note that children whose mothers have been successfully revaccinated previous to their confinements have been vaccinated after birth without result; showing, possibly, that the effect of the mother's vaccination was shared by the fœtus in utero. In investigating this point a large number of observations have been made; the most remarkable of which are those of Burckhardt and Kellock on women, and those of Rickert on sheep. Burckhardt vaccinated 28 pregnant women, and subsequently vaccinated 6 of the children whose mothers had been successfully vaccinated. The operation was unsuccessful in all of them. Kellock (35) vaccinated 36 women in various stages of pregnancy, and found (*a*) that the infants resisted vaccination directly as the stage of pregnancy at which the mother was vaccinated; and (*b*) that the fœtus seemed to be more readily affected in the multiparous than in those of a first pregnancy. His results were as follows:—Of 14 children of primiparas, vaccination was successfully performed on the infant in every case in which the mother had been vaccinated earlier than the 7th month of pregnancy; whilst the operation failed in 5 of the infants whose mothers had been vaccinated later than the 7th month. In the case of the children of the multiparous, no less than 16 proved insusceptible to vaccination, even though in some

[1] Étienne; quoted by Longet.

of the cases the mother had been vaccinated as early as the 5th month. These facts are corroborated by an observation made by Depaul (18), that variola may be transmitted from the mother to the fœtus in utero, and also by some observations recorded in the *Transactions of the Epidemiological Society* (1885-86, vol. v. N.S. p. 166), from which it appears that vaccination failed in three infants whose mothers had suffered from small-pox more than 16 days previous to their confinements, but was successfully performed on three children whose mothers sickened with the disease less than 8 days before the onset of labour.

Some experiments of Straus, Chambon, and Menard (55) have a bearing on this point. They found that the blood serum of a calf, taken before the pocks were healed, produced immunity in other animals of the same species when infused into the venous system. Chauveau has also demonstrated that a generalisation, manifested by an eruption capable of reproducing the ordinary results of vaccination, could be excited by infection of horses through the digestive, circulatory, and respiratory systems, as well as by injection into the subcutaneous tissue (8).

These observations, which are in agreement with the clinical facts, prove that the results of vaccination may be obtained without the production of the local pock: and under given conditions the diffusion of the virus is occasionally demonstrated by the appearance of a cutaneous eruption similar to that which occurs in the acute exanthems, even if it is not entirely analogous to them.

Vaccinia generalised by auto-inoculation.—Allied to spontaneous generalised vaccinia are those sequels of vaccination which are caused by the more or less wide distribution of vaccinal pocks by auto-inoculation. These supernumerary pocks may be caused by scratching with the nails after they have been in contact with the vaccine pocks; or by accidental contamination of surfaces denuded of epithelium by any such cause as eczema or impetigo: they may be produced in any part of the body accidentally brought into contact with virus from the vaccine vesicles. Such cases are common, and references may be found to them in the papers already referred to, especially Dauchez, Longet, and Poole: drawings of remarkable cases are given in my paper in the Clinical Society's *Transactions*, 1893, ii. p. 114, pl. ii., and in Dietter's paper, "Drei Fälle von generalisierter vaccine," Munchen, 1893. The number of pocks varies from one or two upwards; and in the cases in which the eruption has become confluent the number is often very great. The majority of these cases are unimportant, and result only in a little temporary inconvenience, even if the eruption occur on the cheek, lips, tongue, buttocks, or breast; instances of all these cases have been placed on record.[1] Such accidental inoculations have been brought about by the use of handkerchiefs, sponges, ointments, baths and beds which have been used for recently vaccinated infants; and they may

[1] Felkin, R. W., "Note upon Nine Cases of Accidental Vaccination," *Edinburgh Obstetrical Transactions*, vol. xvi. p. 107. See also for references, Sub. "Vaccine Ophthalmie," Fürst's *Die Pathologie der Schutzpocken-Impfung*, p. 104.

occur in the most unexpected ways, as, for instance, in the case of a man who, having chafed himself in riding, applied some vaseline to the sore place out of the same pot which his wife had used for the arm of their child who had been recently vaccinated: the result was a large crop of vaccine vesicles on the buttocks. If vesicles occur on the

FIG. 6.—Vaccinia generalised by auto-inoculation. From a drawing made on the 43rd day after vaccination by Miss M. Green. The pocks *a*, *b*, *c*, *d*, *e*, were about 14 days old; *f*, about 56 hours. *Lymph*, humanised; 42nd remove from calf. *Eruption* round points of inoculation confluent on 14th day. See Fig. 5. *Pocks* continued to appear until the sixth week after vaccination. Mother's breast was inoculated, and the pock ran a normal course. For reference to details of case, see p. 23.

eyelids, or the eyeball, the consequences may be serious; this latter accident, however, is of great rarity. In five cases recorded by Berry the ulceration was confined to the eyelid. The symptoms vary with the seat of the initial lesion and the condition of the patient as regards immunity against vaccinal inoculation (21, 26, 56). Thus infection of a

mother's eye by her child's finger may result in a well-developed vaccine vesicle, infection of the child's own eye after the 8th day may result in an abortive pustule, or in an ophthalmia such as may be produced by any chance contamination with pus, as, for instance, in gonorrhœa. Although the name of vaccine ophthalmia has been given to the affection (Saemisch), there does not seem to be any adequate ground for supposing that it stands in any essential relation to vaccinia, or is other than a purely accidental complication. An inquiry by Mr. Hulke into the alleged occurrence of blindness amongst the pupils at the

FIG. 7.—Vaccinia generalised by auto-inoculation. Pocks from various parts of the body. *c* measured about ½ in. transversely; *e*, ⅞ in.; and *f*, ⅝ in. The drawings were made on the 43rd day after vaccination: *c* was then about 12 days old, and *e* and *f* about 14; *d*, about 48 hours. There was little inflammatory thickening round them; no true induration. In the centre of *e* and *f* there was a clean granulating surface. Cf. Figs. 5, 6, pp. 16, 20.

Royal Normal College for the Blind, Upper Norwood—in which institution, if in any, such cases would probably be found—resulted in the conclusion that, of eight cases alleged to be caused by vaccination, seven were conclusively proved to be due to some other cause; and in the one doubtful case Mr. Hulke found no grounds for attributing the event to the cause alleged.[1]

[1] In comparison with the above it may be interesting to record Dr. Brailey's observations on 763 persons, who for some cause or other had lost an eye: 15 of these had lost their sight from small-pox, of whom 7 (43 per cent) were unvaccinated and suffered from small-pox at an average age of 8·9 years, 4 with no vaccination scar at an average age of 8·2 years, 2 with one scar at an average age of 20 years, 2 with two scars at an average age of 28·5 years.

One other form of accidental auto-inoculation calls for special notice, since mistakes in diagnosis might occasion much unnecessary distress. Cases have been recorded (M. Morin and Behrend (16)) in which sores have been produced around the anus, and on the mucous membrane of the vulva, by the accidental transference with the fingers of pus from the vaccinated arm. It is hardly necessary to point out that such sores, especially if macerated by the contact of the parts and ulcerated, might be looked upon as venereal (as in the instances referred to) if due care were not exercised. A knowledge of the possibility of such an occurrence and the history of the case ought to prevent this error, even if (owing to the position of the sore, and the stage of evolution of the original vaccine vesicle from which the infectious material was derived) the characteristic appearances of the vaccine pock should have been lost.

A definite case of confluent vaccinia, in which the eruption became generalised by auto-inoculation and possibly also by absorption of the virus through the digestive tract, has been recorded by myself (1). In this case it would seem that the abnormal conditions were primarily due to some peculiarity on the part of the child, since the lymph used was the forty-second remove from the calf; and three other children were successfully vaccinated from this child without complication of any kind. The lymph was traced backwards and forwards for three generations, in all twenty-five children were examined in immediate relation to this particular case, the only abnormality detected being that in four out of eight children vaccinated with lymph from the same source, no result followed; whilst in one child, in the fourth remove, twelve supernumerary pocks appeared. A brief chronological summary of the case is given for reference :—

[TABLE

H. J. K., æt. three months; Vaccinated with humanised lymph, 42nd remove from calf. Generalised Vaccinia; Death (Figs. 5, 6, 7).

First week . .	9th November 1892	Vaccination with humanised lymph, forty-second remove from calf. (Of eight vaccinations by three vaccinators with lymph from same source, four were unsuccessful, but without complication or abnormal result.)
Second week . .	16th November 1892	Inspection. Four healthy vesicles, to all appearances normal.
Third week . .	23rd November 1892	The four pocks coalesced into one, and became covered with dark brownish green scab. Innumerable secondary pocks, at first vesicular, formed round points of inoculation, cf. Fig. 3, p. 13.
Fourth week . .	30th November 1892	Secondary eruption pustular; a large pock appeared on back of head, which eventually scabbed and dried up. (Pocks appeared on face, arms, legs, abdomen, and thighs.)
Fifth week . .	7th December 1892	The supernumerary pocks at points of insertion confluent; eventually a large open sore formed.
Sixth week . .	14th December 1892 17th December 1892	No improvement in child's condition. Pulv. hyd. c. creta, gr. ½ given three times a day with some improvement. Pock formed above inner angle of left orbit.
Seventh week .	21st December 1892	Vesicle forming behind right ear; this aborted within 24 hours.
	25th December 1892	Child's condition worse. Mother's breast became inoculated from suckling the child. Pock ran a normal course. Mother had not been revaccinated.
Eighth week . .	27th December 1892	Death.

There is no evidence to show that such cases are due to any particular strain of lymph, whether humanised or taken direct from the calf (51, 31); they are of great rarity, and must be regarded as accidental complications rather than as essential elements of vaccination.

Such a case as that narrated above opens out the whole question of vaccinal immunity, which it would be impossible to discuss at any length in this place. If the observations of Cory, Trousseau, Mognier, Dumont-Pallier, Damaschino, Besnier, and others are conclusive and final, there is evidence to show that under ordinary circumstances the receptivity of an individual to successive vaccinations in series gradually diminishes during the second week, and usually becomes extinct before the fourth.

Cory (9*a*) found that when vaccinations were performed in series by a single insertion on each of eleven successive days, those made after the ninth day were unsuccessful, and he concluded that immunity was attained at this period. It is certain that during the first week after vaccination an individual may be readily

revaccinated or may contract small-pox; for it does not appear that any considerable degree of immunity is established until after the pocks have reached maturity. Immunity probably reaches its maximum about the fourth week after vaccination; but the standard of resistance varies with each individual, and probably also with the dose and activity of the virus. In the case given above, pocks continued to form for thirty days certainly, and probably longer; so that no rule can be made universally applicable. Vaccinia generalised by auto-inoculation may, however, be expected to occur, if at all, before the third week after vaccination.

Great variations may be met with in susceptibility to vaccinia as well as to small-pox, or any of the acute exanthems. It is commonly recognised that one attack of small-pox renders the individual more or less immune against contracting the disease again; and similarly that one successful vaccination protects, at any rate for a time, against the probability of a second successful inoculation. But it would seem that in some persons one attack is no safeguard against a second. This is well illustrated by a case which came under the notice of Dr. Clifford Allbutt, in which a woman had small-pox three times, and was also three times successfully vaccinated. Such a case seems to set at defiance all laws deduced from ordinary observation, and may be regarded as the exception which proves the rule. The following table gives a brief outline of the facts:—

1858.—A. B.; born ——. Mother developed small-pox when infant was eight days old, and child had it in a mild form.
„ When three months old successfully vaccinated (three scars).
1881.—Successfully revaccinated (two scars).
1883.—Mild attack of small-pox.
1892.—(September). Successfully revaccinated (two scars).
„ (November). Unsuccessfully vaccinated.
1893.—Unsuccessfully vaccinated.
1896.—Very mild attack of small-pox; (but indubitable, T. C. A.)

There is strong evidence that this persistent falling away from immunity in this respect existed in other members of this patient's family.

Vaccinia hæmorrhagica.—Besides the cases in which the sequence of events and the appearance of the eruption are analogous to those found in the acute exanthems, there are others in which the pathological position is at present doubtful: in these cases vaccination is followed by an eruption which is more or less "hæmorrhagic." The eruption may vary in intensity, from the faintest petechiæ to general hæmorrhage; and may be characterised by a few scattered petechiæ, subcutaneous ecchymoses, or severe hæmorrhage from mucous membranes, such as hæmaturia. Such cases are extremely rare; and, although there is no direct proof of it, they are probably analogous to the well-known cases of hæmorrhagic small-pox and scarlet fever.[1] They are too few in number to warrant any opinion as

[1] See 3 cases recorded by Dr. Gregory, Bergeron and Barthelemy, Dauchez, *l.c.* pp. 137-139.

to their causation; but, apart from any peculiarity in the lymph, it might be expected that such complications would occasionally arise in scorbutic, rachitic, and cachectic children; the cause which determines the nature of the eruption being rather the condition of the child than any abnormality of the lymph.

Vaccinia gangrenosa.[1]—A disease closely allied to generalised vaccinia, if not a modification of it, has been described by Hutchinson (29), Stokes (54), Crocker (11), and others, under the name of vaccinia gangrenosa. It is to be regretted that this name has been used for another affection of quite a different character; namely, local gangrene or necrosis at the points of vaccination (46*a*). Vaccinia gangrenosa is an acute exanthem occurring at the end of the first or the early part of the second week after vaccination. The eruption begins in the form of discrete papules with an inflamed base, which ulcerate and scab over, pus forming under and round the scab, while the ulceration extends both in depth and laterally. In this way a central black slough is formed, which after its removal leaves an irregular, unhealthy ulcer, often with overhanging edges. The ulcers may be single or confluent. In Crocker's case, from which the above description is taken, the largest ulcers were $\frac{3}{4}$ in. in diameter and $\frac{1}{3}$ in. in depth.[2] Hutchinson observes that the diagnosis of these cases lies between variola, varicella, and vaccinia; and Crocker includes in his account of the disease a fourth affection, "dermatitis gangrenosa," independent of any one of those named, and probably due, as he believes, to some pathogenetic organism —possibly bacillus pyocyaneus. It is not yet possible to state the precise relationships of these cases, but it seems certain that the eruption can be determined by vaccination, and probable that the disease is a true exanthem, possibly allied to variola or varicella; but there is no evidence to decide whether it be due to a mixed infection, or is the direct result of a specific virus acting upon an individual whose tissues are altered by syphilis, tubercle, rickets, or other constitutional malady, all of which have been considered as favouring its production.

Eczema.—Vaccination is performed, in the majority of cases, at a period of life when eczema and other inflammations of the skin are extremely common; and it is no wonder that the operation is sometimes followed by an acute outbreak of such disorders. I have not met with any case in which it seemed probable that the affection was transmitted by the operation; and in many cases which have come under my own observation, and which have been recorded by others, the acute attack following vaccination or injury to the scab is merely a recrudescence of a pre-existing condition; or is an expression of a family tendency. Out of a total of 394 cases of alleged vaccinal injury which have more

[1] For illustrations see Mr. Hutchinson's paper (29) and Crocker's *Atlas of Diseases of the Skin*, pl. xli. fig. 1.

[2] Mr. Hutchinson refers (*loc. cit.* p. 5) to models 206 and 209 in the Guy's Hospital Museum, which he believes to be taken from cases of varicella gangrenosa. He also gives references to other cases besides his own. See also *Archives of Surgery*, vol. iii. 1892, plate xviii.

or less directly come under my own notice during the last eight years, thirty, or about 7·5 per cent, were cases of non-specific skin eruptions ;[1] and there does not seem to be any reason to suppose that vaccination is the specific cause of any large number of severe cases of eczema.

The statistics of 600 cases of eczema which had been under the care of Dr. T. C. Fox show that 249 (41·5 per cent) came under treatment before the end of the first year ; and in forty of these cases eczema is known to have occurred before vaccination. Of 161 cases in which the date of onset is recorded the eruption commenced in eighty before the end of the third month, and in sixty-nine during the next three months. This seems to give *prima facie* ground for supposing that vaccination is not responsible for any considerable increase in the number of cases ; which is the conclusion drawn by Dr. Fox. At the same time it must be noted that there is a definite rise in the numbers in the fourth and in the ninth months, the periods at which the irritation of vaccination and of teething respectively, might be expected to come into play. The actual numbers are as follows :—

0-1 month	33	6- 7 months	10
1-2 months	22	7- 8 ,,	4
2-3 ,,	25	8- 9 ,,	23
3-4 ,,	39	9-10 ,,	1
4-5 ,,	23	10-11 ,,	1
5-6 ,,	7	11-12 ,,	3

In some instances an eczema which has been intensified by vaccination subsequently improves ; but as a rule a pre-existing eczema is made distinctly worse by vaccination, and not only is it undesirable to vaccinate an eczematous child on account of the risk of aggravating the affection, but also because there is danger of causing a generalised vaccinal eruption on the affected parts.

Impetigo or Porrigo.[2]—The occurrence of this contagious affection of the skin after vaccination is little to be wondered at when the conditions under which the children of the poor have to live are taken into consideration. Under any circumstances pus is readily inoculated from one individual to another, so that local superficial sores are produced ; and when such a source of contagion is introduced into a household where the inmates are dirty, ill-fed, and overcrowded, it is obvious that ample opportunity is afforded for the spread of a purulent affection both from and to a vaccinated child. I have seen cases of impetigo which have originated from injury to the vesicles by dirty sleeves, dirty shields, dirty night-clothes, by exposure to infection from purulent discharges in other children, by scratching the vaccination wounds and inoculating distant parts of the body with the finger-nails. A case,

[1] See Case 25, App. ix. R.C.V. 1896, p. 241, and Case 98, p. 273, and Cases 95, 102, 127, etc.

[2] For plates, see *Atlas of Diseases of the Skin*, New Sydenham Society, fasciculus x. pl. xxviii., and *Atlas of the Diseases of the Skin*, by H. Radcliffe Crocker, fasciculus x. pl. xxxix. and xli. Cf. also Cases 24, 82, 129, 196, App. ix. R.C.V.

reported to the Commission as one of vaccinal injury, may be mentioned, exemplifying the lack of attention to cleanliness which is often the main factor in bringing about these kinds of skin eruption, in which I found a child wearing a hat the lining of which was soaked with pus from an impetigo which had occurred a year previously.

It is unnecessary to discuss this question at length: it cannot be doubted that impetigo may follow any wound, vaccinal or other, in which pus is formed; and that the liability to the affection is enormously increased by want of cleanliness and bad hygienic surroundings. It is a more serious question whether these disorders are ever actually communicated by vaccination. If impetigo is due, as is probable, to the presence of pyogenic cocci in the discharges, it is possible that some lack of care in the selection of the vaccinifer might lead to the inoculation of one child from another. I have only investigated one case in which there was any evidence that such communication might have occurred; and in this instance the vaccinifer did not begin to suffer from impetigo until some days after the lymph had been taken from his arm, so that there was no proof that the child was capable of communicating the disease at the time that he was used as a vaccinifer. It is also possible that both vaccinifer and sub-vaccinee may have suffered from the subsequent eruption in consequence of accidental contamination of the vaccination wounds by the lancet used for the operation.[1]

In foreign countries groups of cases of impetigo have followed vaccination in such a manner as to leave little or no doubt that the affection was communicated by the operation.[2] The lesson to be learned from these cases is obvious; namely, that there is risk in using any individual suffering from a communicable disease as a source of lymph.

Herpes tonsurans.—The accidental inoculation of the tricophyton tonsurans in the process of vaccination has been observed abroad (Hagar (25), Eichstadt (21)), but I am not aware that any case has occurred in England. Like many other communicable skin diseases, it is common in poor and ill-cared-for children; and it is not surprising that in rare instances vaccination should be the means by which it is transmitted from one child to another.

In the case of an affection of the skin so readily communicable from one child to another as tinea tonsurans, it may be fallacious to conclude that the disease was transferred in the act rather than at the time of vaccination; since to undress a number of children in a hot, crowded waiting-room, such as that in which vaccination is sometimes performed, must facilitate the distribution of the spores, and render infection more than usually easy.

Pemphigus; Psoriasis. — The occurrence of these affections after vaccination has been recorded (Dauchez (17), Rioblanc (50)); but if any connection exist between the operation and the eruption it is as yet

[1] See Case 180, App. ix. R.C.V. p. 366.

[2] See Fürst, *loc. cit.* p. 72, and Third Report R.C.V. 1890, p. 135, and Peiper, *loc. cit.* p. 64.

undetermined. If it should be proved eventually that these diseases result from the inoculation of specific cocci or saprophytes, it may perhaps be shown that in rare instances they are communicated by vaccination; but up to the present time no sufficient evidence has been brought forward to show that this is probable. It is certain that in some cases the individual vaccinated was predisposed to and had suffered previously from skin eruptions similar to those which appeared subsequently; and in others that the child vaccinated was in a cachectic condition as the result of some affection, which had lain dormant until roused into activity by the constitutional disturbance of vaccination.

The influence of the exanthems on the course of vaccination is not easy to determine. It is certain that such chronic or subacute affections as eczema, impetigo, and possibly psoriasis, are not uncommon causes of generalised vaccinia (*q.v.* p. 19); but whether the acute specific fevers—such as scarlet fever, measles, and varicella—can determine and precipitate a general cutaneous vaccinal eruption is a question which, for lack of sufficient data, cannot as yet be definitely stated.

The difficulty of arriving at any precise knowledge on these points is greatly increased by the fact that the nature, extent, and variety of post-vaccinal eruptions have hitherto received inadequate recognition; so that cases of generalised vaccinia have been regarded as variola, and cases of erythematous, vesicular, or papular eruptions, as scarlet fever, chicken-pox, or measles.

It is probably rare for vaccination to be complicated by any one of the acute specific fevers; and still more rare, should this happen, for any abnormality to occur. In isolated cases it is often a matter of great difficulty to decide whether an erythematous rash is scarlet fever, or a vesicular rash varicella. Cases have come under my own notice, as well as under that of others, in which there were grounds for supposing that errors of diagnosis had been made; as, for instance, cases in which a simple vaccinal eruption had been regarded as evidence of invaccinated syphilis.

It would not be unreasonable to suppose that the course of a vaccination performed during the incubation period of scarlet fever or measles might be disturbed, and that the tissues at the point of inoculation might undergo necrosis similar to that which occurs in noma or cancrum oris; but even if such cases do occur, they are so rare that we are compelled to regard them as accidental complications which are inevitable in all conditions of life, and of pathological interest rather than of clinical importance. Dr. Hopwood, for many years resident at the London Fever Hospital, informs me that he has himself vaccinated a considerable number of persons in all stages of scarlet fever, and has seen many vaccinated by others under similar circumstances, without any evil result. He has also seen persons vaccinated shortly before an attack of scarlet fever, and yet in them no serious complications. In estimating the importance of facts observed by the resident

medical officer of a well-equipped hospital, it must be borne in mind that vaccination wounds are much more likely to pursue a normal course in the cleanly conditions of an hospital, than in the crowded and often filthy surroundings in which many children are compelled to live; and that given a case of vaccination, complicated by scarlet fever, in some miserably poor home, it will be well-nigh impossible to decide with certainty which of the many unfavourable conditions had been mainly instrumental in bringing about any abnormal result which may occur.

There is reason to believe, however, that under favourable conditions normal vaccinia can run parallel with scarlet fever, varicella, and even with variola, if the latter be contracted before immunity is secured.

The influence of congenital syphilis on vaccination.—The statement has not infrequently been made that it is difficult or even impossible to obtain a normal vaccine vesicle in a child who is suffering from congenital syphilis.[1] This certainly is not the case. If the child be not cachectic, vaccination may pursue a normal course, and the vesicles may be good, giving no indication whatever of the danger of collecting lymph from them for further vaccinations. This fact is of the utmost importance in the selection of a vaccinifer. The diagnosis of congenital syphilis must be made from an examination of the child, and a knowledge of its family history; and no reliance whatever should be placed on the appearance of the vaccinated arm. If the vaccinated child be cachectic there is a danger that vaccination may be followed by ulceration or sloughing at the point of inoculation; or that some one of those complications may arise which occur in feeble children, who have little or no power of resistance against local inflammation.

The influence of vaccination on latent disease.—Symptoms of scrofula,[2] tuberculosis,[3] congenital syphilis,[4] sometimes occur after vaccination; and the lesions, without adequate ground, are apt to be attributed directly to vaccination. It is in accordance with ordinary clinical observation that disease, hitherto quiescent, should be lighted into activity by some factor which is not specifically concerned in its causation. Thus a mechanical injury, an acute specific fever, prolonged anxiety, or insufficient food, are often followed by pulmonary or meningeal tubercle, or by some other local manifestation of tuberculosis.

Primary vaccinations are frequently performed at or about the period when symptoms of congenital syphilis may be expected to declare themselves; and cases have come under my observation in which children known to have been previously suffering from congenital syphilis have been vaccinated, and in whom the subsequent evidences of syphilis have been put down to vaccination.[4] In a particular instance it may not be easy to prove that a lesion which follows vaccination is not directly the result of the operation; but in most instances the history of the case, if

[1] *British Medical Journal*, 1880, vol. i. p. 191.
[2] Cases No. 131, p. 307, and No. 187, p. 374, Appendix ix. R.C.V. 1896.
[3] Case 187, p. 374.
[4] Cases No. 227, p. 413; No. 309, p. 438; and cf. Cases 198, p. 386; 202, p. 389; and 326, p. 447, *loc. cit.*

fully inquired into, will give conclusive evidence as to the real origin of the malady.

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Part III

Vaccinal Injuries. Alleged and Real.

Introduction.—The practice of vaccination has been opposed on three grounds:—(i.) *Theoretical.* It is said that vaccinia and variola are totally distinct diseases, and that the inoculation of cow-pox does not therefore exercise any specific protective power against small-pox (3). (ii.) *Statistical.* It is stated that so-called cow-pox is nothing else than human variola artificially transmitted; and that statistics of small-pox epidemics demonstrate not only that vaccination does not protect against small-pox, but that it actually causes it.[1] (iii.) *Practical.* It is alleged that the injuries caused by vaccination are so numerous, and so terrible, that there is no justification for the continuance of a practice which may be powerless for good (29*a*).

This is not the place to discuss the first two propositions, which, if both were true, would be mutually destructive. The third proposition, namely that which relates to the extent and severity of vaccinal injuries, is one which deserves the most careful study. It is alleged that syphilis, tubercle, and other diseases, such as cancer and lupus, have been inoculated at the time of vaccination; and that pyæmia, erysipelas, and various other inflammatory affections result directly from the operation of vaccination as it is at present performed. Syphilis and tubercle have not infrequently been inoculated in the rite of circumcision (20*a*, 24*a*), in tattooing (13*b*), and in other purely accidental ways (13*a*, 24*b*). It might therefore seem probable, on *a priori* grounds, that in the practice of vaccination there is real danger to be apprehended from these sources. The purpose of the following pages is to inquire how far these allegations are borne out by fact; and, if admitted to be substantially correct, to endeavour to ascertain in what proportion of cases injury has been found to occur.

The influence of vaccination on general infantile mortality is discussed in the Final Report of the Royal Commission on Vaccination, paragraphs 377 and 378, p. 105; the following passage epitomises the present state of knowledge on the subject:—

"Without encumbering our report with the details relating to pyæmia, bronchitis, diarrhœa, and skin diseases, which are all said to have increased owing to the mischievous influence of vaccination, we may confidently say that there is no evidence to justify the statement. It is, however, worth while pointing out, that comparing as before the

[1] Vogt, Prof. Adolf (Bern), *Memorial concerning the Effect of Vaccination*, etc., chap. ii. p. 692, "Identity of Variola Vaccina and Variola Vera," chap. viii. p. 707, "Variola Epidemics produced by Vaccine Inoculation." Paper forwarded to the Royal Commission on Vaccination. Appendix to Sixth Report R.C.V. p. 689 *et seq.*

period 1883-87 with the period 1863-67, the increase of deaths under one year of age from diarrhœa and dysentery in Leicester was 4·2 per cent, whereas in England and Wales it was 0·5 per cent. A similar comparison in respect of bronchitis shows the increase in Leicester to be 112·8 per cent, in England and Wales 73·3 per cent. It seems clear that as regards general infantile mortality Leicester has not gained by its avoidance of vaccination. Whilst in England and Wales the mortality of children under one year of age had between the periods selected for comparison decreased 7·5 per cent, in Leicester the decrease was only 2·8 per cent. Upon the whole, then, we think that the evidence is overwhelming to show that in the case of some of the diseases referred to, vaccination cannot have produced any effect upon the mortality from them, and that it has not in the case of any one of them increased the mortality to a substantial, we might even say an appreciable extent."

That harm occasionally results from vaccination in individual cases cannot be doubted; but whether the number of cases in which injury is inflicted be large or small, it is interesting to note that the annual infantile death-rate has not increased since vaccination was made compulsory; it has, in fact, diminished. (See Final Report R.C.V. p. 102, para. 385.) The actual numbers are—1838-42, 152 per thousand births; 1847-50, 154; 1851-60, 154; 1861-70, 154; 1871-80, 149; 1881-90, 142.

It is obvious that these figures give no certain data for determining the actual number of deaths which result directly or indirectly from vaccination; neither does the diminution in the annual death-rate show that no deaths result from the operation; but they indicate that no appreciable increase in the death-rate, whether due to vaccination or not, has occurred. There are also other data available for forming a reasonably accurate estimate of the facts.

Statistics of deaths and injuries. — The number of deaths or of serious injuries which result annually from vaccination may be arrived at with considerable certainty. From the Registrar-General's returns it appears that in the years 1881-89 the number of deaths certified as connected with vaccination was 476, or nearly 53 a year. During these nine years 6,739,902 primary vaccinations were performed. This gives an average of 1 death to 14,159 primary vaccinations. During the three years from 1st November 1888 to 30th November 1891, 205 alleged cases of injury were inquired into by the medical department of the Local Government Board; and from 1st June 1889 to 1st July 1896, 421 additional cases were investigated by the Royal Commission on Vaccination. Of the cases inquired into by the Local Government Board, Dr. Coupland and I came to the conclusion that in approximately 20 per cent the influence of vaccination was doubtful. Of the cases investigated for the Commission by Dr. Barlow and myself, about 16 per cent were probably altogether unconnected with vaccination; while of the cases inquired into by Dr. Luff, nearly 40 per cent are placed by him in the same category.

As these figures are and can only be taken as an approximation to the actual facts, it is probable that no serious error will be made in supposing that, of the total 626 cases investigated, some 20 per cent may be set aside as unconnected with vaccination ; leaving 495 cases of death or vaccinal injury which have been adequately inquired into during the last eight years : this gives an annual average of 61·3, or a slightly larger number than that which is arrived at from the Registrar-General's returns, which refer to cases only in which death has occurred.

From these statements it will be seen that, however valuable to the community at large, vaccination is not exempt from that liability to accident which exists in all human affairs. Operations even of a trivial kind sometimes prove fatal; and that most beneficent means of alleviating pain which has been universally adopted—the administration of anæsthetics—is not unattended by risk, and occasionally results in death. The percentage number of deaths which occur annually in England from chloroform is far greater than that which results from vaccination. It is, in fact, nearly seven times as great ; and though the risk from ether is much less, the percentage number of deaths per annum traceable directly or indirectly to anæsthetics is appreciably greater than that which follows vaccination,[1] while the total number is approximately the same. It cannot be argued that the rare fatalities attendant upon vaccination which occur are sufficient ground for rejecting the practice if it can be proved to be beneficial on the whole. If the practice of vaccination is to be discredited, it must be by showing that the injury thereby inflicted on individuals is out of all proportion to the good which is gained by the community ; and not by exaggerating, distorting, and multiplying every isolated instance of injury which occurs. The following pages have been written with the object of stating fairly what is the amount and kind of injury inflicted by vaccination as at present practised ; how much of it is inevitable, how much preventable, and by pointing out the dangers, to show incidentally how many of the risks may be avoided.

In this, as in other branches of pathology, it is incumbent on the medical profession to impose on itself, as a condition of assenting to any doctrine, the obligation of setting forth conscientiously all that can be said against it, no less than all that can be said in its favour.

Erysipelas.—*Relative importance of inflammatory complications.*—Among the complications of vaccination, those are most to be dreaded which are common to all wounds. The most grave are erysipelas, cellulitis, ulceration, abscess, and septicæmia. None of these are peculiar to vaccination ; they constitute the dangers of any local lesion of the skin ; and, considering the age of the children vaccinated, the conditions under which thousands of

[1] I am indebted to Dr. Childs, secretary of the Anæsthetics Committee, Brit. Med. Association, and to Mr. G. Rowell of Guy's Hospital, for the actual figures, which are as follows :—Deaths from anæsthetics recorded : 1891, 46 ; 1892, 41 ; 1893, 46 ; 1894, 66 ; 1895, 61 ; 1896, 8½ months, 48. The deaths from chloroform are roughly 1 in 2000, and from ether 1 in 20,000.

them live, and the treatment to which in defiance of the most elementary principles of cleanliness the wounds are often subjected, it is surprising that, as investigation proves, so few cases of serious injury occur.

The relative importance of these inflammatory complications may be gathered from the fact that of 205 cases investigated by the Local Government Board,[1] and 189 cases investigated by Dr. Barlow and myself (11) (all of which have been fully inquired into, and as far as possible placed under definite headings),[2] 133 and 94 respectively come under the category of "inflammatory."[3] In other words, of 394 cases of alleged vaccinal injury recorded during the years 1888-1895 with which I have had directly or indirectly to deal, no less than 57·6 per cent resulted from one or other of the specific forms of inflammation. The percentage is, indeed, considerably higher than this; since many of the cases in which the suspicion of invaccinated syphilis has been raised, proved on investigation to be cases of vaccinal ulceration, or some other such lesion; and might properly, therefore, have been included in the inflammatory class. Thus, approximately, 60 per cent of all cases of vaccinal injury in this country are probably due to some form of inflammation; erysipelas being the most important and of the most frequent occurrence.

To form some estimate of the frequency of post-vaccinal erysipelas recourse may be had to the statistical and clinical facts which were laid before the Vaccination Commission (18). It will be seen from the returns of the Registrar-General for Scotland, that during the years (1855-1863) immediately preceding the Act for making vaccination compulsory in Scotland, 28·36 per cent of all deaths from erysipelas occurred during the first six months, and 5·02 per cent in the second six months of life; and that during the years (1864-1887) which immediately followed the passing of the Act, the numbers were 28·88 and 5·35 per cent respectively. This shows conclusively that no new cause, resulting in a different distribution of mortality from erysipelas, came into play in consequence of the passing of the Vaccination Act. Again, the Leicester statistics show that, comparing the years 1883-1887 (at which time vaccination had largely fallen into abeyance) with the years 1863-67, the infant mortality from erysipelas, which in England and Wales had decreased 16·7 per cent, in Leicester had increased 41·5 per cent. The comparison here made is between Leicester and the whole of England and Wales, a comparison not perhaps strictly exact; but the figures are remarkable, and warrant the conclusion that the neglect of vaccination in Leicester did not at any rate lessen the number of deaths from erysipelas amongst the infant population.

[1] An analysis prepared by Dr. Sydney Coupland and Dr. T. D. Acland of the Reports made by Inspectors of the Local Government Board, Appendix ix. to Final Report R.C.V. 1896 (1).

[2] These figures do not give the total number of cases investigated by the medical officers of the Commission, but refer only to those reported on by Dr. Barlow and myself.

[3] For classification adopted, see Appendix ix. *loc. cit.* p. 2.

Erysipelas may be defined, according to present knowledge, as an acute specific inflammation of the skin caused by definite micro-organisms, and characterised (i.) by a tendency to spread, mostly by continuity; and (ii.) by a general intoxication running parallel with the local inflammation.

It has been suggested, without adequate proof, that erysipelas following vaccination is "a stage in the evolution of cow-pox"—"a throwing back to one of the original characters of that communicable infection" (14); and that it is "the prime note of vaccination" (31). These hypotheses were anticipated by Bohn, when some twenty years ago he wrote that "the clear, pure lymph of a true Jennerian vesicle possesses the power of engendering erysipelas" (12). It does not admit of doubt that these statements, made in the first two instances with the object of bringing the practice of vaccination into disrepute, are not founded[1] upon any more secure basis than that erysipelas sometimes starts from the vaccination vesicles, as it may start from any wound.

It is possible that the virus of erysipelas may be, and sometimes though rarely is, introduced with vaccination; but no proof has been brought forward to show that the vaccine lymph commonly contains this virus, or that erysipelas is a necessary or essential part of vaccination.

Pfeiffer, Crookshank, Landmann (23), Kitasato, Sternberg, Copeman, and others have demonstrated (*a*) that vaccine lymph may contain organisms capable of producing erysipelas; but they have also shown that, so far as present knowledge goes, none of these organisms is the specific organism of cow-pox: and (*b*) that vaccine lymph which has been deprived of all known[2] living pyogenetic organisms, still produces the characteristic effects of vaccination (26). It follows from this that complications which result from the presence of streptococcus pyogenes aureus, erysipelatosus, and other pathogenetic organisms, are, so far as can at present be stated, accidental, and in no way an integral part of the process of vaccination.

Landmann (24) has shown that lymph which contains no known pathogenetic and but few saprophytic organisms, gives unusually good results when used for vaccination. In forty persons vaccinated with such lymph the areola in no case exceeded $\frac{3}{8}$ inch in breadth; and Kitasato's (21) experiments have led him to the conclusion that the inflammatory symptoms which not infrequently follow vaccination are mainly if not entirely due to the presence of extraneous pathogenetic organisms in the lymph.

These researches prove—

[1] It is not of any practical importance whether Jenner thought that the inflammation excited by the cow-pox was "erysipelatous" or not. There is no necessity for limiting the pathological knowledge of to-day by statements made nearly 100 years ago (1799). See *Further Observations on the Variolæ Vaccinæ*, by Edward Jenner. Reprinted by E. Crookshank, 1889, p. 187.

[2] As stated in the introduction, p. 3, there is some ground for believing that vaccinia is caused by a specific contagium, as it is not capable of cultivation on ordinary media. (Klein and Copeman.)

(i.) That the virus of erysipelas is entirely distinct from the virus of vaccinia, and has no necessary pathological connection with it.

(ii.) That it is possible to prepare vaccine lymph which is entirely free from those pathogenetic organisms which are known to excite the specific forms of inflammation.

(iii.) That vaccine lymph freed from all living pyogenetic or saprophytic organisms has not lost thereby its power of producing characteristic vaccine vesicles.[1]

(iv.) That lymph containing the streptoccocus of erysipelas may, if the dose be sufficient, excite erysipelas starting from the point of inoculation.

The incubation period of erysipelas.—Much evidence has been adduced from cases in which the initial lesion was known, to show that this period may be as short as two hours, and possibly in exceptional cases as long as eight days. Thus in thirty-one out of thirty-six cases recorded by Tillmanns it was three days or less; and in a large majority of cases it was less than sixty hours.

The length of the incubation period of post-vaccinal erysipelas seems to correspond with Tillmanns' observations; since, in many cases in which there has been evidence to show that the lymph was at fault, the erysipelas began at an early period after vaccination; that is, within the limits of time which experimental or accidental inoculation has shown to be the probable incubation period of the disease: and it may be stated generally that the sooner after vaccination erysipelas occurs, the more likely it is to have been invaccinated. In a great majority of cases post-vaccinal erysipelas begins during the second week after the operation, at a time when the normal incubation period of erysipelas is probably long passed, and when, pus being formed at the point of vaccination, there is a ready "nidus" for the reception of any of those wound infections which so frequently follow mechanical injuries resulting in a breach of surface.

Whether erysipelas inoculated at the time of vaccination can remain dormant for days or weeks is a question to which at present no definite answer can be given. Some of the coincidences which have come under my notice are remarkable. For instance, eleven children were vaccinated on the same day (2); in one case only two pocks formed, and on the eighth day the child was revaccinated from one of his co-vaccinees, in two places. Both these children, who lived many miles apart, and as far as I could ascertain never met again, and were not attended by the same doctor, sickened with erysipelas within twenty-four hours of one another about the twenty-sixth day after vaccination, and died within four days of one another, thirty-nine and forty days after vaccination respectively. In another case the vaccinator, apparently ill at the time, died of erysipelas four days after inspecting a child's arm which was inflamed. The child died four days later, also of erysipelas.

[1] Fürst concludes that the vaccine virus is contained in the living cellular elements, and that no form of bacterium has yet been cultivated outside the body capable of producing definite vaccine pocks. (*Loc. cit.* p. 9, *q.v.* for a summary of the various opinions on this matter.)

In 1891 I undertook a series of experiments on calves and rabbits, with the object of determining (if possible) whether, were the virus of erysipelas inoculated simultaneously with vaccine lymph, the disease might remain in abeyance until the formation of the pustule on the eighth or ninth day. It is conceivable that with a weak virus in a strongly "refractory" individual the appearance of erysipelas might be delayed until the resistance of the tissues had been overcome by the formation of pus at the point of inoculation; and that a dose of the virus, which under ordinary circumstances would have been inoperative, might then give rise to symptoms after the normal incubation period (about three days) of erysipelas had passed. These experiments did not, however, solve the problem completely; the conditions were necessarily so different from those of vaccination that any deductions made from them would require rigorous criticism.

In the numerous cases of post-vaccinal inflammation which I have investigated I have found that, as a rule, when erysipelas occurred more than three or four days after vaccination, it was impossible to obtain adequate proof that it had been invaccinated; or proof that it was due to the condition of the instruments used, or to some act on the part of the vaccinator at the time when the operation was performed.

Cases of vaccinal erysipelas.—In the following cases of vaccinal erysipelas there is sufficient evidence for concluding that the lymph or method of vaccination was the actual cause of the disease.

1. Two children were vaccinated with lymph stored in tubes; both of these children died with symptoms of general diffuse inflammation of the skin which spread over the entire body. In the first child the inflammation was well marked by the third day; in the second child the first vaccination failed entirely, but it was revaccinated from the same source: "soon" after the second vaccination the arm became red and swollen, and by the fourth day the inflammation had spread to the elbow. The tube from which this revaccination was made, and another of the same batch, were examined by Dr. Klein with the following results:—

(*a*) The former showed the presence of numerous colonies of the streptococcus of erysipelas.

(*b*) The latter yielded cultures of staphylococcus pyogenes albus liquescens.

These cases support the belief that lymph, contaminated with specific organisms in sufficient quantity, may be expected to show the results of the inoculation of such organisms, whether vaccination be successful or not; and may give rise to local symptoms within a few hours of inoculation, before the vaccine vesicle has had time to arrive at maturity: that is to say, the course of the erysipelas in all probability will not be delayed by the vaccination, but will be the same as if inoculation with the micro-organism had taken place apart from the vaccination (3).

2. Five children were vaccinated from the same source (4); in four of these erysipelas subsequently appeared, and one died. The

vaccinifer sickened with erysipelas ten days after lymph had been taken from its arm. The cases are noteworthy for several reasons :—

(*a*) It will be seen from the following table that the severity of the symptoms varied inversely as the length of the incubation period.

(*b*) All the sub-vaccinees of the vaccinifer (who himself subsequently suffered from erysipelas) did not suffer from erysipelas ; one escaped entirely ; the others suffered in varying degrees, and the initial symptoms appeared at varying intervals after inoculation.

These gradations in the severity of symptoms, and length of incubation period, are in harmony with what is known of such factors as dosage, virulence, and receptivity, which determine the effect produced by any given virus.

Case No. 115

Table showing date of appearance of erysipelas, etc., in a vaccinifer and four sub-vaccinees.

No. in Register.	First appearance of Erysipelas after Vaccination.	Severity.	Course.	Result.
Vaccinifer— No. 157, A. S.	17 days	Slight.	Subacute.	Recovery.
Sub-Vaccinees—No. 166, M. H.	6 hours	Great diffuse swelling ; abscesses.	Acute.	Death on 20th day.
Do. No. 163, B. S.	16 hours	Great diffuse swelling ; pyæmia.	Subacute.	Abscesses on scalp, scapula, shoulder joints, wrists, etc. ; not fatal.
Do. No. 164, F. H.	5 days	Less severe ; no suppuration.	Subacute.	Recovery.
Do. No. 165, T. W.	19 days	Less severe ; axillary abscess after 5 weeks.	Chronic.	Recovery.
Do. No. 167, T. C.	None	...	...	Vaccination normal. Six children successfully vaccinated from this case.

3. In another series of cases there was ground for believing that some infective material had been introduced with the vaccine lymph. Sixteen children were vaccinated : in four of them septic symptoms appeared within 12 hours ; in four within 36 hours ; in three within 60 hours ;

in two before the fourth day; in one before the eighth day. Of one there is no record (5).[1]

The following table is of interest as showing the dates after vaccination at which erysipelas appeared in 100 cases which have been adequately investigated. Of these, ninety-six were inquired into and reported upon by the medical staff of the Local Government Board; the remaining four, added to complete the hundred, were investigated by myself (6). It shows that the great majority of cases occurred at a date after vaccination outside the limits of what is believed to be the normal incubation period of erysipelas. Only nine cases occurred in the first three days, while no less than ninety-one appeared during the subsequent weeks.

No deduction must be made from this table as to the relative frequency of erysipelas after vaccination with the various kinds of lymph; since it is impossible to ascertain the total number of vaccinations performed in England with lymph derived from each of the several sources named during the period to which reference is made.

[1] The details of these cases, which were inquired into by Dr. Barlow and Dr. T. H. Thompson, will be found in Appendix ix. Final Report R.C.V. p. 229; the reports are of such length as to prohibit their introduction here, even in abstract.

[TABLE

TABLE showing date of appearance in 100 cases of post-vaccinal erysipelas occurring between November 1888 and February 1892.

	Erysipelas occurring in						Vesicles known to have been opened.
	No. of Cases.	First Week.	Second Week.	Third Week.	Fourth Week.	Fifth Week.	
HUMANISED LYMPH							
1. Arm to arm . .	48	First day 3 Fifth day 3 Sixth day 2 Seventh day 4	23	10	1	2	15
2. Tubes . . .	18	Sixth day 1 Seventh day 1	8	7	0	1	3
3. Tubes N.V.E. . .	1	...	1				
4. Points N.V.E. . .	3	Third day 1	2	...	...	...	2
5. Method of preserving not stated	6	Second day 1 Fifth day 1	3	1	...	...	1
CALF LYMPH							
1. N.V.E. direct from calf . . .	2	...	2	...	...	...	1
2 Other sources—tubes	6	Second day 1 Sixth day 2	3	...	...	...	1
3. N.V.E. points . .	1	...	1				
4. Conserve—source not stated . . .	1	...	1	...	...	...	1
5. Source and method of preserving doubtful	2	Sixth day 1	1				
SOURCE OF ORIGIN NOT STATED	12	Second day 3 Fourth day 1 Seventh day 4	4				
Totals . .	100	29	49	18	1	3	24

The history of the nine cases in which erysipelas supervened in the first three days is important. In two instances pathogenetic organisms were found in tubes of lymph from the same source as that which had been used to vaccinate the children.[1] In five cases there was strong evidence for believing that the lymph was at fault; since more than one child out of each of the three groups of vaccinees (vaccinated on the same day) to which these children belonged suffered from erysipelas; and in each instance the vaccinifer suffered from superficial inflammation of the arm. In one case a child was vaccinated with a tube of lymph which had been opened a week previously; another was vaccinated when three weeks old, in an infirmary, the bedding on which the mother and child slept having been in a ward in which a case of erysipelas had occurred: the ward had, however, been "fumigated" with sulphur. Thus in all these cases of early post-vaccinal erysipelas, except possibly the

[1] Cf. Cases of vaccinal erysipelas, p. 37

last, there were circumstances which make it probable that the erysipelas was due to some extraneous cause which came into play at or about the time of vaccination.

Such cases might be multiplied; but enough has been said to show that symptoms may be expected early in those instances in which there is ground for believing that erysipelas, or some septic infection, was introduced at the time of the operation: and, further, that the symptoms may vary greatly in intensity.

It seems probable, if one only of a number of children vaccinated from the same source develop erysipelas later than the fourth or fifth day, that the erysipelas is due to some extraneous cause, and is not invaccinated. On the other hand, if a number of children vaccinated from a common source develop erysipelas before the fourth day, only one or two of the whole batch escaping, the probability is very great that the erysipelas is directly due to the lymph or to some factor introduced at the time of vaccination.

Erysipelas starting from vaccination wounds may be communicated to other persons, as is proved by the records of some of the foundling institutions; notably those of Vienna and St. Petersburg. In the former no less than 31·47 per cent of the deaths were due to erysipelas.[1] Nor is this to be wondered at: the children were vaccinated indiscriminately, the weakly with the strong, often when they were but seven or eight days old. The lymph was collected by the attendants; the vaccine pocks were plastered with zinc powder, until stinking pus exuded from below the scabs (13), and the daily bath was forbidden. Allusion is made to these cases since they have been instanced by a recent writer to show that "the erysipelas engendered in the process of vaccinal infection, or, in other words, by *exaggeration of the normal areola* and infiltration, may become the source of erysipelatous contagion to others, just as erysipelas of other origins may so become" (15). That erysipelas following vaccination may be communicated to other persons is beyond doubt; but this fact does not prove that erysipelas is an integral part of vaccination, although it is certain that it frequently follows vaccination when simple and well-known principles of hygiene are disregarded. In the Foundling Hospital at St. Petersburg, after the adoption of such ordinary rules of cleanliness as are essential to the well-being of all infants, especially of the feeble or the very young, the number of cases of erysipelas was reduced by two-thirds.

No attempt has been made hitherto to show that the areola which forms round healthy vesicles can actually communicate erysipelas to others; or that it contains micro-organisms which are capable of exciting the specific forms of inflammation (16). Even if it be capable of proof that the areola is caused by extraneous pathogenetic bacteria, and not solely by the irritation of the developing pustule, no evidence has yet been

[1] In Würtemburg, during the same time, only one case of post-vaccinal erysipelas was ascertained to have occurred amongst 500,000 children living under ordinary conditions (Fürst, *loc. cit.* p. 69).

adduced to show that these organisms play any essential part in the process of vaccination.

From Tillmanns' experiments, and from clinical observation, it would appear certain that erysipelas need not necessarily start from the point of infection (9). This latter point is of interest as bearing upon the question whether the areola be "erysipelatous." It is certain that erysipelas may occur before the areola is formed, as well as after it has subsided; that it may involve the areola, and subside, leaving the areola still round the vesicles; and that it may occur in a distant part of the body while the areola is still present.

Sources of danger independent of the lymph.—Apart from any intrinsic qualities in the lymph, and independent of all sources of danger from the methods employed in its collection and storage, there are elements of extraneous and often readily avoidable risk in the circumstances of the infant, and in the method in which the operation is at times performed. The use, in one case, of a mechanical scarifier which it was practically impossible to clean, and, in another, of ivory points which had frequently been recharged, may be instanced.

Hypotheses concerning the nature of vaccinal erysipelas which do not take these and such causes into account are likely to be fallacious. The facts are that erysipelas is common in infants, especially as a result of open wounds; and that vaccination acts as nothing more than an exciting cause, not infrequently providing the starting-point.

Vaccinal ulceration and glandular abscess.—Of the other inflammatory complications which may follow vaccination, those of the most frequent occurrence are ulceration at the point of inoculation, and glandular abscess. Nearly 4 per cent of the vaccinal injuries inquired into by the Local Government Board (1888-1891) were due to one or other of these lesions; and in all the cases some extraneous cause was found which might have determined the departure from the normal. An enumeration of some of the many local applications which I have known to be made to the vaccine pocks, and which may well be regarded as the origin of ulceration or suppuration, will be found on p. 60. Disaster on a large scale, in times now long past, has been courted[1] by using as a source of lymph "The shirt sleeve of a patient stiff with purulent discharge from a foul ulcer,"—"Matter found in great plenty on the sleeves of children's shirts,"—"Lymph in one instance taken from vesicles on the ninth day; the vaccinifer, three months old and suffering from twelve pocks, being carried from village to village and used to vaccinate 104 children." This list might be extended, but such examples sufficiently show the ignorance of some persons who have undertaken to perform vaccination; the results —"deep-seated ulcerations and violent inflammations"—being such as might be expected from such disregard of the most elementary laws of hygiene and cleanliness.

[1] Creighton, *The Natural History of Cow-Pox*, pp. 115-118, *q.v.* for references to the original documents.

I have seen several cases in which ulceration of the pocks, glandular abscesses, erysipelas, and even septic intoxications followed the vaccination (7) of infants whose conditions of life were unfavourable. Amongst these are included illegitimate children born in destitution, and, it may be, vaccinated when a few days old, in a workhouse infirmary: from the comparative comfort of which they are removed before the vaccinated arm is well, to surroundings which could not fail to be harmful even to a healthy child. It is not to be wondered at that such infants, ill clothed and worse fed, a burden to their mothers, and sometimes with their lives insured, should succumb to an operation even so trivial as vaccination. No mention would be made of such cases here were it not that they have frequently been made the subject of legal inquiry, and the child's death attributed to vaccination. In the majority of cases in which inflammatory complications follow vaccination there are numerous factors which tend to bring about the catastrophe; and it is illogical to draw any definite conclusions as to the origin of the lesion without giving full weight to the extraneous influences which, apart from vaccination, may have been brought to bear upon the individual case. Under the heading Syphilis, p. 62, will be found tables giving the points of difference between vaccinal ulceration and syphilitic chancre; but it may briefly be said here that, as a rule, vaccinal ulceration is well marked at a time when syphilitic chancre would not yet have developed; and that vaccinal eruptions, if present, differ widely from those which occur as secondary phenomena in acquired syphilis (cf. p. 63). Their development is irregular, their distribution unsymmetrical, they are often intensely irritating, and they tend to conform to the various forms of erythema and urticaria rather than to the papular, squamous, and macular eruptions of secondary syphilis.

Gangrene at the point of vaccination.—In isolated cases gangrene occurs at the point of vaccination, and it sometimes follows vaccination in syphilitic subjects. One such case is reported by Balzer; one by Wheaton. I have myself investigated two cases (8), in one of which the syphilitic parentage is certain and in the other probable. It is not unreasonable to suppose, if the individual vaccinated be the subject of inherited disease, and the operation be performed when the child is very young, that the result is largely due to the condition of the tissues, and not necessarily to any abnormal quality of the lymph. Three cases have been recorded and summarised by Mr. Hutchinson (20) in which there was no known exciting cause for the local lesion except the fact that the child had been vaccinated: it is probable that none of these children was syphilitic, and it is possible the phenomena may have been the result of idiosyncrasy in reference to the vaccine virus. Mr. Hutchison instances, in support of this view, the occurrence of noma and cancrum oris, forms of spreading gangrene which have nothing to do with syphilis, but which may occur as sequels of the acute specific fevers, such as measles or scarlet fever.

Such cases have not infrequently been mistaken for syphilis, and in making the diagnosis it is necessary to bear in mind the natural history and evolution of that disorder. The differential diagnosis will be found on p. 62.

Tetanus[1] may follow as an accidental infection of any wound; as a complication of vaccination it is of the utmost rarity. I am only acquainted with one case of tetanus in more than five million vaccinations in this country (cf. Case x., App. ix. R.C.V. p. 6), and in none of the recorded cases is there any evidence that the tetanus was invaccinated. It has been known to follow vaccination in South Africa in a series of adult natives, who immediately after being vaccinated worked under a tropical sun. Such cases as the latter require no comment; they only show that ordinary caution is necessary even in so slight an operation as vaccination.

Other wound infections, such as *osteomyelitis* (36) and *icterus* (?) (32), are stated to have followed vaccination, nor is this surprising considering the vast number of vaccinated children living in every degree of dirt, destitution, and misery. None of these have come under my own observation; and, so far as I am aware, no cases have occurred in the United Kingdom during the last ten years. So far as the practice of vaccination is concerned they are of no importance; for they only emphasise the fact, which needs no demonstration, that any wound may become septic if the conditions are unfavourable; and that, given an infected wound, the results will depend primarily on the nature of the contamination, and, in a less degree, on the peculiarities of the individual.

Septic infection in relation to various kinds of lymph.—There are no accurate data for determining whether erysipelas and the "septic infections" are more common after the use of calf lymph, or humanised lymph; or of lymph stored in tubes, on points, or as a conserve.

It has been thought that the use of "calf lymph" might afford some increased security against these inflammatory complications; and this supposition seemed to be corroborated by the fact that diffuse inflammation round the pocks in calves is rarely observed. No case has been recorded at the Lamb's Conduit Establishment; Voigt in 1888 had seen one case only amongst 2500 calves; in conjunction with Dr. Carl Menge,[2] I have found that calves are singularly refractory to inoculations of the streptococci of erysipelas, even in association with vaccinia. Our observations are corroborated by Klein (22).

In my own experiments no diffuse inflammation was produced in

[1] *Archives of Dermatology*, 1880, p. 188, contains a reference to a case recorded by Ross, *Southern Clinic*, 1879, vol. i. p. 468. Toms, *Medical News*, 1894, vol. lxiv. p. 209, *q.v.* for reference to five other cases; symptoms of tetanus did not supervene in any of the reported cases within three weeks of vaccination, six out of the seven cases have proved fatal.

[2] Unpublished observations by Carl Menge, M.D., Strasburg, and T. D. Acland, M.D., Aug. 1891.

calves by inoculation (after linear scarification of the skin) with (*a*) streptococci cultivated direct from a case of acute facial erysipelas; (*b*) virulent cultures direct from Prof. Fraenkel of Königsberg; (*c*) culture from the same source five months old; (*d*) serum from the blisters in a case of acute facial erysipelas; (*e*) cultures of micrococcus pyogenes aureus and albus from a virulent case of cellulitis. In the latter case the vaccination, which was performed simultaneously, pursued a normal course. Culture (*a*), when injected subcutaneously into the ear of a rabbit, produced inflammation within thirty-six hours, and suppuration in less than sixty hours. These experiments are not complete; but they are in accordance with the observed facts that superficial wounds, such as those caused by vaccination, do not so readily become the starting-point of erysipelas or cellulitis in the calf as in man; and that a virulent culture sufficient to cause abscesses in one species of animal may not produce any evident result in another. Again, these facts are in agreement with the well-known axiom that the effect of any contagion depends not only on the dose and the virulence of the poison, but also on the susceptibility of the individual inoculated.

Reliance must not, however, be placed on the comparative insusceptibility of the calf to erysipelas and septic infections through superficial wounds, to secure the immunity of vaccinated children from erysipelas. Most of the inflammatory sequels of vaccination, if not all, are due to causes which are removable, and therefore, under certain conditions, preventable; the lymph itself rarely contains organisms capable of directly causing erysipelas, and it is probable that all pyogenetic organisms can be removed from lymph, by treating it with glycerine (*vide System of Medicine*, vol. ii. p. 652). The result of my own observation leads me to the conclusion that vaccination, as now performed directly from the calf, is, *cæteris paribus*, followed by greater inflammatory reaction than when humanised lymph is used; but, as stated above, there are no trustworthy figures to show the percentage of cases of erysipelas or cellulitis which follow vaccination by either method.

In the earlier days of vaccination, when even serious surgical operations were performed with little regard to cleanliness, and when the causes and prevention of sepsis were not understood, the collection, storage, and use of lymph for vaccination was not carried out with the care necessary to prevent contamination with pyogenetic or pathogenetic organisms. There is good ground for the hope that the researches of Sternberg, Kitasato, Landmann, Copeman, and other pioneers, will lead to improved methods of obtaining and preparing vaccine lymph; and that persons having the care of vaccinated children will learn that many of the so-called results of vaccination may be avoided. It will then be found that the one complication of vaccination most to be feared, comparatively infrequent as it now is, will, except in the rarest instances, be unknown.

The results obtained by Voigt (of Hamburg), whose experience has extended over a period of twenty years, during which time he has

performed some quarter of a million vaccinations, may be taken as fairly representing what is possible. His observations are the more important as he has special arrangements for tracing and investigating every case of vaccinal complication. During the last five years, out of 100,000 vaccinations, he has seen one case of axillary abscess; two of abscess (locality not stated); one of furunculosis; two of erysipelas; and five of vaccinal ulceration, with only one death. But it must not be forgotten that to secure such results nothing may be omitted which can help to make the operation aseptic. There are many possibilities of sepsis from the belly of the calf, the opened tube, the recharged point, the mechanical vaccinator which cannot be or is not sterilised, the hands of the operator, and the infant's surroundings. These dangers, if recognised, can often be avoided but cannot be disregarded, even in so simple an operation as vaccination. There is no ground for believing that the septic complications of vaccination are "stages in the evolution of cow-pox," or "throwings back to its original characters"; but there is much evidence to show that the methods at present employed for the production, storage, and use of lymph occasionally fail to reach that perfection of asepsis[1] which is necessary in any surgical operation, however small, and which is especially necessary in the case of very young children.

REFERENCES TO PART III. ON VACCINAL INJURIES

1. *Appendix IX. to Final Report of Royal Commission on Vaccination*, 1896, p. 2.—2. *Ibid.* Case 106, p. 277.—3. *Ibid.* Cases xxxi. and lxv., pp. 13, 24.—4. *Ibid.* Case 115, p. 289.—5. *Ibid.* Case 23, pp. 229, 233.—6. *Ibid.* Cases 124, 163, 164, 166.—7. *Ibid.* Cases 113, 118, 207, 309.—8. *Ibid.* Cases 202, p. 389, and 207, p. 395.—9. BALLARD. Table R.C.V. Appendix, p. 209.—10. BALZER. *La France médicale*, 1890, quoted by Martin, *New York Medical Record*, 1890, p. 44.—11. T. BARLOW and T. D. ACLAND. *Letter to the Chairman of the Royal Commission on Vaccination*, unpublished. —12. BOHN. *Handbuch der Vaccination*, Leipzig, 1875, p. 174.—13. *Ibid. Pathologie der Vaccine*, Leipzig, 1875, p. 175.—13*a*. BOLLINGER, Prof. "Ueber die Infectionswege des tuberculosen Giftes," III. Abtheilung für *Allgemeine Pathologie und pathologische Anatomie des X. Internat. Congres zu Berlin*, 1890.—13*b*. COLLINGS, D. W., and MURRAY, W. "Three Cases of Inoculation of Tuberculosis from Tattooing," *British Medical Journal*, 1st June 1895.—14. CREIGHTON. *The Natural History of Cow-Pox and Vaccinal Syphilis*, Lond. 1887, p. 105.—15. *Ibid. Loc. cit.* p. 105.—16. *Ibid. Loc. cit.* p. 103.—17. CROOKSHANK. Evidence before the R.C.V. Fourth Report, p. 48, Questions 11,058, 11,104, 11,135, and 11,218, etc.—17*a*. CROOKSHANK, E. M. *The History and Pathology of Vaccination*, Lond. 1889, vol. i. p. 464.—18. *Final Report Royal Commission on Vaccination*, 1896, p. 105.—19. FÜRST. *Loc. cit.* p. 101.—20. HUTCHINSON. *Archives of Surgery*, i. pp. 97-116. Cf. also R.C.V. Sixth Report, pp. 216-223.—20*a*. HUTCHINSON, JONATHAN. "On Syphilis conveyed in Circumcision," *Syphilis*, p. 115. Lond. 1889.—21. KITASATO. *Sei-i-kwai:* Medical Journal, Tōkyō, 1896, pp. 91 and 176.—22. KLEIN. "Observations on the Concurrent Inoculation of different Infections in the same Animal Body," *Report of Medical Officer of Local Government Board*, 1891-1892, pp. 126, 127.—23. LANDMANN. *Hygienische Rundschau*, 1895, p. 975, and 1896, p. 441.—24. *Ibid. Loc. cit.* p. 976.—24*a*. PEIPER, E. *Internationale klinische Rundschau*, 1889, p. 72. —24*b*. *Ibid.* "Zur frage des Uebertragung der Tuberculose durch die Vaccination,"

[1] The question of bacterium-free vaccine lymph was discussed at the 68th Versamml. Gesellschaft Deutscher Naturforscher und Aertze zu Frankfurt a. M. Sept. 1896. Cf. also Neidhart, *Hygienische Rundschau*, No. 21, 1896, p. 1073, and *Chemiker Zeitung*, Oct. 1896, p. 788.

Internationale klinische Rundschau, 1889, p. 73.—25. Pfeiffer. "Ueber Impfkrankheiten," *Deutsche med. Wochenschrift*, 1892, p. 198.—26. Sternberg. *Medical Record*, New York, 1896, p. 677.—27. *Ibid.*—28. Tillmanns. "Erysipelas," *Deutsche Chirurgie*, Stuttgart, 1880, p. 96.—29. Voigt. "Ueber Impfschäden," etc., *Wiener medizinische Presse*, 1895, p. 294.—29*a*. Wallace, Alfred R. *Vaccination proved Useless and Dangerous*, Lond. 1889, p. 38.—30. Wheaton. *Trans. of the Path. Soc.* 1893, p. 140.—31. White, Wm. *Story of a Great Delusion*, 1885, p. xxxix.

Part IV

Vaccination and Syphilis

Introduction.—No part of the study of vaccination is more serious or more surrounded with difficulty than the attempt to estimate at their true value the conflicting statements concerning the transmission of syphilis by this operation. It is true that invaccination of syphilis is possible; but the facts brought before the Royal Commission (1889-1896) prove that, in England at any rate, the event is one of great rarity, and they do not justify any grave objection to the practice of vaccination.

Two methods, the statistical and the clinical, have been adopted to estimate the number of cases of vaccinal syphilis which actually occur. Of these the former is the less satisfactory, since it is liable to many sources of error; and although such figures as are available go far to prove that infantile syphilis has not been increased by vaccination, there is still stronger evidence against its frequency, in the fact that, although every alleged case of invaccinated syphilis brought before the Commission which had occurred between the years 1889 and 1896 was subjected to a searching inquiry, not one of them stood the test of an investigation into all the circumstances. During the years specified approximately five and a quarter million primary vaccinations were performed in the United Kingdom.

Of the cases vaccinated in 1889, and previous to this date, which were inquired into, one[1] was believed by Mr. Hutchinson and Dr. Barlow not to be a case of syphilis at all. In another (No. 141, App. ix. R.C.V.) the evidence was so indefinite that Dr. Barlow and I came to the conclusion that though there was some ground for the allegation, it was incapable of proof. This child had been vaccinated in 1880, twelve years before the inquiry was made; and at the time of the investigation there was no evidence of syphilis, invaccinated or otherwise acquired. Only three other cases were brought directly before the Commission in which there was *prima facie* ground for suspecting that syphilis had been communicated by vaccination,[2] and two of these cases had occurred twenty-five years previously.

If further evidence as to the rarity of the disease be needed, it may

[1] See Case No. 1 of the Commission series, and Case 90, L.G.B. series, Appendix ix. R.C.V.; also Hutchinson's *Archives of Surgery*, vol. i. No. 2, 1889, pp. 106 and 112.

[2] See Final Report R.C.V. pp. 110-114, and par. 424, p. 111.

be noted that amongst 30,000 patients at the Hospital for Sick Children, Great Ormond Street, a place where if such cases were of common occurrence they would be met with, Dr. Robert Lee has seen only one instance of supposed vaccinal syphilis; while at the East London Hospital for Children, Dr. Radcliffe Crocker has not seen or heard of one such case, although for many years he has been making special inquiries as to their occurrence.

Statistical method of inquiry.—During the last twenty years the number of deaths in England and Wales "registered" as due to syphilis has increased:[1] it has been suggested that this increase is due to syphilis inoculated at the time of vaccination.[2] The limit of age at which vaccination must be performed is, for this division of the United Kingdom, three months. As a matter of general experience vaccination is delayed as long as possible, so that any increase in the number of deaths from syphilis due to the operation would probably occur in children of more than three months old. Such however is not the case, the disease is most largely fatal during the first three months of life; so that whatever be the cause of this increase of syphilis, there is no evidence to show that it is due to vaccination.

In Scotland, where the age limit is six months, during the period 1855-1863, which immediately preceded that of compulsory vaccination, out of every 1000 deaths at all ages registered as from syphilis, 575 occurred during the first six months of life, and 109 between the ages of six and twelve months. During the period 1864-1875 the number of deaths registered as from syphilis during the first six months was 612; and in the period 1875-1887 it was 647. During the same periods the proportions of deaths registered as from syphilis between the ages of six and twelve months were 118 and 109 respectively. Thus in Scotland the number of deaths from this cause occurring during the second six months of life, when the results of vaccination would be most likely to declare themselves, shows no increase after vaccination had been made compulsory; the registered deaths during the months preceding the age limit for vaccination having at the same time increased.[3]

In Ireland the number of deaths from infantile syphilis has largely diminished during recent years. In 1864-1865 the average number of deaths so registered was 124; in 1887-1888 it was only 40.

In Leicester, where the practice of vaccination had fallen largely into disuse, the deaths registered as from infantile syphilis for the years 1883-1887 showed an increase of 69·3 per cent as compared with an increase of only 24·7 per cent for the whole of England and Wales for the same period. It need hardly be said that this increase is in no way connected with the disuse of the practice of vaccination; but it shows that the

[1] Final Report R.C.V. p. 103.

[2] Cf. also *Cow-Pox and Vaccinal Syphilis*, by Charles Creighton, p. 145, London, 1887, where the increase is attributed, not to syphilis inoculated with vaccination, but directly to vaccination itself, the results being erroneously called syphilis.

[3] Final Report R.C.V. pp. 101, 102. The statistics are given on the authority of the Superintendent of Statistics in the office of the Registrar-General for Scotland.

neglect of vaccination in Leicester has not been followed by any diminution in the number of deaths from infantile syphilis.

For the sake of comparison attention may be directed to the German statistics, from which it would appear that no case of vaccinal syphilis was recorded during the years 1889-1893 amongst a total of twelve and a quarter million vaccinations and re-vaccinations (30, 35), in the great majority of which "calf" lymph was used.

Whatever percentage of error is to be allowed in these statistics, it is evident from the above figures that they emphasise the fact, which, as we shall see, may fairly be deduced from clinical experience also, that the risk of inoculation of syphilis with vaccination is almost incalculably small.

Clinical method of inquiry.—Turning now to the clinical aspect of the inquiry, it is necessary to distinguish accurately between actual and alleged cases of vaccinal syphilis.

That many of the recorded cases are not syphilitic there can be little doubt. This may be said more especially of those which occurred in the early part of the century; but even at the present time cases are reported as vaccinal syphilis which, upon careful examination, do not appear to be of this nature (27). In those cases which I have had the opportunity of investigating, I hesitated to believe that the phenomena in question originated vaccination alone. They generally showed wide divergences from invaccinated syphilis so far as it is known; and almost without exception some extraneous factor was present in each case which determined the character of the phenomena which followed the operation. In some instances there was evidence of culpable negligence of those simple precautions without which no operation is justifiable, and without which any surgical procedure such as vaccination may well be followed by disaster (5, 32).

I have not obtained sufficient evidence in the course of my inquiries to lead to the conclusion that certain rare cases to which reference is here made are reversions to an original type of vaccinia; they appear rather to be abnormal results occurring in the course of a definite affection, such as sometimes complicate any of the acute specific fevers.

To illustrate these cases I would specially refer to (*a*) Mr. Hutchinson's paper on three fatal cases of gangrenous ulceration of the arm after vaccination (20); (*b*) case of simulated vaccination syphilis (21); (*c*) the various cases included under Section D in the Abstract of Reports by Inspectors of the Local Government Board, made by myself and Dr. Coupland; (*d*) Cases 52, 94, 109, 113, 195, 202, reported by myself; (*e*) series 139, investigated first by myself alone, and subsequently with Dr. Barlow; (*f*) finally, to the "Leeds Case," No. 1 of the Commission's series, probably the most important of all.[1] These are given in full in Appendix ix. to the Final Report of the Royal Commission on Vaccination, 1896. From these reports it will be seen that although in each case the invaccination of syphilis has been alleged, and, as in the Leeds case, the allegation has been stoutly defended, yet the conclusion arrived

[1] Cf. also Hutchinson, *Archives of Surgery*, 1889, p. 112.

at, after carefully weighing all the facts that can be elicited, is that none of them was due to this infection. It was found that some were cases of gangrenous ulceration, some the result of vaccination in children suffering from congenital syphilis; and, whatever the origin of the lesion, each individual case presented facts which seemed to be incompatible with the view that the symptoms were those of syphilis inoculated at the time of the operation. The manifestations of syphilis are protean; and in doubtful cases no safe deduction can be made from isolated symptoms. Before any conclusion can be drawn as to the true nature of the disease, it is essential to take into consideration the complete history of the case, its evolution, the date of appearance, and the kind of lesions produced. It cannot be doubted that neglect of such precautions has led in many instances to confusion and to mistaken diagnosis. Amongst the cases inquired into by myself, I have found that the formation of a sore at the point of inoculation a week after vaccination, appearing rather to be syphilitic than vaccinal, the occurrence of periosteal swellings which arose a week after vaccination in a case unquestionably septic, the occurrence of cutaneous eruptions presenting "a certain suspicion of syphilis" during the second and third weeks,—have each in their turn been taken as evidence of invaccinated syphilis, without regard to the fact that a particular symptom isolated from all others is of small weight in deciding the true nature of a given case. Further, such symptoms become of even less value as evidence when they have appeared "untimely"—that is, at a moment when, from what we know of the natural history of the disease, the initial sore of syphilis would not have arrived at maturity, and at a period when neither secondary nor tertiary symptoms could have had time to declare themselves. Cases showing the difficulty of eliminating such sources of error will be found in Mr. Hutchinson's *Archives of Surgery*, vol. i. p. 97, and in the reports by myself to the Royal Commission on Vaccination, Nos. 109, 113, 207, 416, and others. It would not be possible here to enter into these cases in detail.

In his evidence before the Commission (Sixth Report R.C.V. 1895, p. 159, Q. 21,854), Mr. H. H. Taylor put forward the following table of "alleged cases of vaccinal syphilis," at the same time expressing the opinion that it is impossible in many of them to say whether "the signs which followed vaccination were the manifestations of syphilis or cow-pox."

This table is too untrustworthy to be of any service in estimating the actual number of cases of vaccinal syphilis which occurred during the years specified; but it is important as showing the extreme difficulty of obtaining accurate information on the subject.

The danger of drawing any conclusion from it is well illustrated by the fact that, although Mr. Taylor handed it in as a table of alleged cases of vaccinal syphilis, Dr. Collins and Mr. Picton (4) allude to it as a list of cases of vaccino-syphilis; and both Mr. Taylor and Dr. Creighton use these same cases as evidence that the so-called vaccinal syphilis is nothing but cow-pox. No further testimony is needed to show the inextricable confusion of the whole subject.

English Cases of "Alleged Vaccinal Syphilis," taken from Mr. H. H. Taylor's Table. See Appendix Sixth Report R.C.V. 1895, p. 617. Foreign cases have been omitted.

N.B.—The references given have in some instances been amended.

Date.	Place.	Number of Cases.	Authority.	Remarks, T. D. A.
1. 1802	London	1	Letter from Mr. Smyth Stuart in Squirrell's *Observations on Cow-Pox*, 1805, p. 39.	No mention of suspicion of syphilis at place of reference. The words are, "I was led to consider the cow-pox virus possessed a specific scrofulous nature."[1]
2. 1859	Manchester	14	Whitehead, Third Report, Clinical Hospital, Manchester, 1859, p. 51.	Inconclusive. Evidence very meagre. No details given sufficient to exclude congenital disease. No facts given in support of the suspicion raised.
3. 1871	London	21	Hutchinson, *Illustrations of Clinical Surgery*, fascic. vi. pp. 115 and 122.	Recorded by Mr. Hutchinson as cases of vaccinal syphilis — as are also those marked †.
4. 1871	London	1	T. Smith, *Clinical Society's Transactions*, 1871, vol. iv. p. 53.	Probably a case of invaccinated syphilis, but report very incomplete. No mention of vaccinifer nor co-vaccinees.
5. 1872	London	1	Hutchinson, *loc. cit.* p. 126.	†
6. 1873	London	1	Hulke, *Med. Times and Gazette*, 1873, p. 153.	No details. Mr. Hulke said he had seen a case which he believed to be vaccinal syphilis. No facts given in support of the suspicion raised.
7. 1876	London	1	Hutchinson, *loc. cit.* p. 128.	† Should be two cases. Mother contracted syphilis from suckling her child; primary sore on nipple; symptoms followed two months later than in children. Father contracted disease from wife.
8. 1883	London	40	Transactions of the *Vaccination Inquiry*. Edited by M. D. Makuna. Part I. 1883.	Quite unreliable. Sixteen correspondents say they have seen cases, but no details are given.
9. 1883	London	1	Druitt, quoted by H. Lee: Holmes' *System of Surgery*, ed. ii. vol. iii. p. 349.	Case did not occur in England. No details. Dr. Druitt saw the case abroad and made a sketch of it.
10. 1889	London	2	*Archives of Surgery*, vol. i. p. 97.	Recorded by Mr. Hutchinson as not being vaccinal syphilis; although two were thought by some who saw them to have been syphilitic.
11. 1890	,,	3	Do., vol. i. p. 193.	
12. 1891	,,	1	Do., vol. ii. p. 213.	

[1] Creighton, *loc. cit.* p. 113, states that the word "venereal' stood in the original, but was suppressed, and "scrofulous" substituted; the words "suspected venereal taint" appear in

Some further comment is needed on two of the above series, Nos. 2 and 8.

No. 2.—Dr. Whitehead (38) gives a table of sixty-three cases (out of a total of 2584 patients) which he believes to have been syphilitic; and out of this number fourteen are attributed to vaccination. In none of these cases is the condition of the vaccinifer or co-vaccinees mentioned; there is no evidence to show that they were examined: in three cases only is it definitely stated that the father and mother were healthy, and even as to these, no statement is made that either father or mother was examined. Deductions drawn from such uncertain data must obviously be liable to many fallacies.[1]

No. 8.—This series is useless for accurate purposes, no details are given in Mr. Makuna's Inquiry; sixteen observers say that they have seen cases of invaccinated syphilis (twenty-one cases), but their replies are very inconclusive, and there is nothing to show which of those who answered Mr. Makuna's "Inquiry" had seen particular cases, or whether more than one of them had seen the same case.

Clinical history of vaccinal syphilis.—The inoculation of syphilis at the time of vaccination may be due to various causes: (i.) To direct contamination of the lymph taken from a vaccinifer suffering at the time from syphilis (9, 28, 35). (ii.) To accidental contamination of the instrument or wound. (iii.) To infection from the vaccinator. It has been suggested (19) that infection might be conveyed by a vaccinator, suffering at the time from syphilis, blowing out the lymph from the capillary tube, but there is no evidence that such an accident has ever taken place.

In whatever way syphilis be invaccinated a certain definite sequence of events may be expected. These are as follows: if the person vaccinated be susceptible to vaccination the pocks may not at first show any departure from the normal course, but in some cases the pocks abort, and the pathological process seems to be at an end until the syphilitic virus asserts itself. If the pocks be irritated, or the condition of the tissues be such as to favour suppuration, the vaccinal sore may become inflamed, suppuration may occur, and the ulcers may for a time scab over and then break down again; but under any circumstances, whether the vaccination pursue a normal or an abnormal course, a true syphilitic chancre with indurated base eventually forms at the point of inoculation.[2]

Dr. Cory's experiments on himself, reported by Bristowe, Hutchinson, Humphry, and Ballard, throw valuable light on the clinical history of invaccinated syphilis; and the sequence of events in vaccinal syphilis may be studied from this case, which was carefully observed and recorded (33).

a version of the letter published by Dr. Smyth Stuart two years after Squirrell's *Observations* were published. Cf. *An Address on Vaccination*, etc., by Ferdinand Smyth Stuart, Esq., London, 1807, pp. 9 and 68.

[1] Creighton (5) uses these cases as an argument in support of his view that vaccinal syphilis is not of "venereal" origin at all, but due "to the inherent although mostly dormant natural history characters of cow-pox itself."

[2] Fournier, *loc. cit.* p. 125. Cf. also table on page 55 for further references.

R. C. purposely vaccinated himself on four occasions from children known to be syphilitic. On the first occasion, in 1877 or 1878, vaccination was successful, but the vesicles matured early and declined after the fourth or fifth day. No syphilitic trouble followed. Some two years later he vaccinated himself again from a tainted source. Neither vaccinia nor syphilis resulted. About eighteen months later he repeated the experiment, again with negative results.

On the fourth occasion he was vaccinated in three places (34), from a child who was selected as being obviously the subject of congenital syphilis. She had suffered from thrush, snuffles, and a cutaneous eruption. At the time the lymph was taken from her arm she had sores on the right buttock and the left nostril; and there was still a cutaneous eruption, though not in the immediate neighbourhood of the vesicles, which were normal and not inflamed: they were shallow, however, and difficult to prick without drawing blood. The lymph was collected on a cleansed lancet, the utmost care being taken to avoid any admixture of blood. The next day the three insertions were red, with small areolas which declined gradually, and the arm was entirely healed in six days. On the twenty-first day a red papule formed at two of the points of inoculation: these slowly enlarged, and on the thirty-first day one began to desquamate. The papules continued to increase in size up to the thirty-fifth day, a slight areola being occasionally visible. On the thirty-fifth day a little yellow spot appeared in the centre of one of the papules, and by the next day a scab had formed over it. Two days later (the thirty-eighth day) the scab which covered this papule was removed, and a small ulcer was found beneath it. On this day the arm was seen by the late Sir George Humphry and by Mr. Hutchinson; both observers considered the lesions to be syphilitic. The diseased parts were then removed with antiseptic precautions, and five days later almost all tenderness had disappeared; but for the first time an enlarged and painless gland was felt in the axilla.

Next day, the forty-fifth, the lower wound was indurated, and the punctures caused by the needles, with which the edges of the wound had been united, had sloughed; and increasing pain was felt in the axilla. For the next four days the pain in the axilla was severe, and the glands were enlarged and tender; and on the fiftieth day, the constitutional symptoms having been gradually increasing, there was a distinct feeling of illness. Two days later, blue pill (5 grains daily) was taken with much benefit; but on the fifty-fourth day rheumatic pains were felt, followed within forty-eight hours by much soreness of throat; next day, the fifty-sixth, the cervical glands became painful; on the fifty-seventh day a roseolous eruption appeared on the forehead, the temples, the back of the neck below the ears, and the lower part of the abdomen, which lasted four days; after this date antisyphilitic treatment was fully carried out.

The subsequent history of the case shows that the experiment was only too successful.

TABLE giving symptoms and dates in a case of Invaccinated Syphilis (R. C.)

Stage.	Date.	Symptoms.
Primary . .	1st day, July 1, 1881.	Inoculation in 3 places on left forearm.
	8th ,,	Arm healed.
	21st ,,	Papules at points of inoculation.
Secondary .	35th ,,	Earliest appearance of ulceration.
	38th ,,	Chancres of ordinary syphilitic type, at one point of inoculation. Parts inoculated excised.
	44th ,,	Glands first noticed to be enlarging.
	45th ,	One wound indurated.
	47th ,,	Sore throat.
	54th ,,	Pains in limbs.
	57th ,,	Roseolous eruption lasting four days only.
	88th ,,	Acne chiefly on back.
Tertiary . .	21 weeks.	Indurated mass began to form on left thigh (gumma). This inflamed and broke down.
	23 ,,	Two gummas, and a little later tenderness over tibia (? periostitis).
	7 months, 1882.	Throat sore, other symptoms better.
	$7\frac{1}{2}$,,	Headache.
	8 ,,	Acne spots fading, wounds of gummas healing.
	8-13 ,,	Some occipital headache, worse at night. Pupils unequal, right generally the smaller.
	14 ,,	Tingling in right hand. Vertigo. Tingling right foot, intermittent at first, then constant.
	$15\frac{1}{2}$,,	Loss of power on right side.
	September 17, 1882.	Slight aphasia.
	1-2 years.	Symptoms gradually passed away. No evidence of syphilis $2\frac{1}{2}$ years after inoculation.

The deductions which may be made from such a case are important, and bear out what has been frequently observed :—

(*a*) That vaccination can be successfully performed with lymph taken from a source tainted with syphilis without necessarily communicating the disease (10, 37).

(*b*) That if syphilis be communicated in the process of vaccination it does not follow that all the points of insertion will become infected (11).

(*c*) That the evolution of syphilis, as regards the primary and secondary stages, is not necessarily disturbed, that it is neither accelerated nor retarded by simultaneous vaccination (12, 8).

(*d*) That no care in the selection of lymph obviates the risk of vaccinating from an obviously tainted source (13, 7).

(*e*) That when syphilis is communicated by vaccination the first

appearance of the disease is at the seat of puncture ; and that there is no evidence of general infection until a much later period.

For the sake of clearness a table of the symptoms of vaccinal syphilis, as they have been generally observed, is given below, comparing them with those present in R. C.'s case.

Symptoms of Invaccinated Syphilis.		Symptoms in R. C.'s Case.
1. Chancre . .	Initial chancre at point of vaccination invariable.	Initial chancre at point of inoculation.
2. Glands . . .	Indolent swelling of glands. Duration of the above prolonged without treatment.	Axillary glands at first enlarged without pain ; subsequent pain much relieved by mercury.
3. Evolution . .	Regular.	Regular.
(*a*) Incubation . .	No definite effect before the end of 3rd week, usually end of 4th or even 5th (24).	Papule 1st, noticed at end of 3rd week.
(*b*) Chancre . .	Of ordinary syphilitic form.	Chancre of ordinary syphilitic form.
(*c*) Second incubation .	Second incubation period.	Second incubation period.
(*d*) Generalisation .	Generalisation takes place between the 50th and 70th days ; if disease is untreated 6th - 10th week, Hutchinson, [1] 9th - 10th, Fournier (15).	Rheumatic pains on 54th day, roseolous eruption on 57th day.
4. Eruption . .	At first roseolous, generally on abdomen. Subsequently polymorphic, symmetrical. Infrequent on hands and face (25), except in severe cases. Condylomata at junctions of mucous surfaces, common.[2]	At first roseolous on abdomen, forehead, temples, neck.

For further details and for tertiary symptoms see table p. 54.

As care is almost universally exercised in the selection of lymph there is little danger of producing such aberrant results as are seen when pus is inoculated at the same time as the syphilitic virus. In such cases the initial symptoms may be perplexing, and the true nature of the lesion may be only detected during the subsequent history of the case.

Various important questions arise in the consideration of cases of vaccinal syphilis.

i. Is it necessary that, as in the case of R. C., the vaccinifer should

[1] *Syphilis*, by Jonathan Hutchinson, 1889, p. 114, if without treatment 6-10 weeks, if treated with mercury 5-7 months ; cf. also *Illustrations of Clinical Surgery* (by the same author), London, 1877, p. 133.

[2] For illustrations of invaccinated syphilis see *Illustrations of Clinical Surgery*, by Jonathan Hutchinson, London, 1877, plates xxii. xxiii. xxiv., and *Syphilis*, by the same author, plate iii. p. 104 ; also cf. Fig. 9, p. 61.

be obviously syphilitic; or can the virus be communicated from a child apparently in good health?

ii. What is the actual vehicle by which the virus is transmitted?

iii. Given a healthy vaccinifer, can syphilis be communicated in the act of vaccination independently of the lymph?

iv. Can syphilis be communicated in lymph taken directly from the calf?

(i.) As regards the first proposition, none of the recorded cases seem to me to prove beyond doubt that a child not in the active stage of syphilitic infection can communicate the disease; though Fournier (16) and others appear to think that it is possible.

Mr. Hutchinson's cases (23, 29) have been accepted as evidence on this point; but it is possible that the infection may have been conveyed by the lancet from another child, and not from the vaccinifer at all.

With regard to this point it is most important to remember that, as has been stated (cf. p. 29), vaccination may pursue a typically normal course in a syphilitic child provided that it is not cachectic.

(ii.) The question of the actual vehicle by which the virus is transmitted has long been under discussion. M. Viennois (de Lyon) was of opinion that the virus is contained in the blood. It has been asserted by Barthelemy,[1] and later by Husband,[2] that it is practically impossible to collect lymph in the ordinary way which does not contain blood corpuscles; so that, if collected from vesicles on a syphilitic individual, apparent clearness of the lymph is no security (cf. Deduction, *d*, p. 54).

(iii.) The following cases have been mentioned by Voigt as supporting the view that syphilitic infection may be communicated from a child's co-vaccinees.

At Tauberbischoffsheim four children were vaccinated from an infant whose mother was a woman of the town: this child died shortly after being used as a vaccinifer. All four sub-vaccinees subsequently presented symptoms of syphilis; three were probably of syphilitic parentage, and inasmuch as the vaccinifer at the time the lymph was taken from its arm is said to have shown no sign of congenital disease, it is suggested that the fourth was infected from one of its co-vaccinees (1). The evidence is very inconclusive; especially as the physician, under whose care the vaccinifer was when he died, suspected some inherited taint. The vaccinifer seems to have been selected without regard to the ordinary precautions which should invariably be taken in every instance. Such instances show the importance in all cases of suspected vaccinal syphilis of investigating the history of the co-vaccinees, and of the vaccinifers in the direct line, for some generations; lack of information on these points must invalidate any deductions subsequently made as to the source of infection.

(iv.) It is probably impossible for syphilis to be conveyed by lymph taken directly from the calf, even though the calf had been vaccinated

[1] Fournier, *loc. cit.* p. 112.
[2] Final Report R.C.V. 1896, p. 112, par. 430.

from a syphilitic child; it has been shown by Koch that the syphilitic poison is destroyed by passing through the animal, and there is no evidence to show that cattle are susceptible to this disease (18). The foregoing statement shows from clinical evidence that although it is possible to transmit syphilis in the act of vaccination, it is of very rare occurrence, and is not to be feared if ordinary precautions are taken.

The disease is stated to have been transmitted from a syphilitic vaccinifer in some fifty series of cases during the last century (26). Even if this estimate be approximately correct, it shows that amongst the many millions of vaccinations, the danger to an individual of contracting syphilis through the operation is inappreciable; and that such indeed is the fact is borne out by a statement made by Mr. Hutchinson to me some little time ago that he had not seen a case of vaccinal syphilis for ten years —evidence as to its rarity more convincing than a multitude of statistics.

Differential diagnosis of vaccinal syphilis.—It remains to call attention (i.) to the main differences which have been found to exist between vaccinal syphilis and other lesions following vaccination; (ii.) to the points which may lead to the correct differentiation between invaccinated syphilis and vaccinia occurring in a syphilitic child; and, lastly, (iii.) to the points of difference between vaccinal ulceration and vaccinal chancre.

(i.) *The differences between vaccinal syphilis and other lesions which may follow vaccination* are well illustrated by the Leeds case,[1] which has been alluded to more than once. In this instance the child when vaccinated was nearly four months old. She was the third in the family, was at the time in good health, and had been previously so. The parents, the vaccinifer, and the co-vaccinees, so far as could be ascertained, were all healthy and without any signs of syphilis. On the sixth day some inflamed spots formed at the seat of inoculation; the inflammation spread rapidly, and towards the end of a fortnight two deep ulcers had formed with much dusky swelling round them. The inflammation and ulceration spread, and at the end of the month the child seemed ill. There was some false membrane on the velum and tonsils, and aphthæ appeared in the mouth; subsequently an ulcer formed on the upper eyelid, and one over the ear on the same side as the vaccination. Nine and a half weeks after the operation all the points of insertion had sloughed into one, producing a large unhealthy ulcer; and the two sores mentioned above were phagedenic. Nothing abnormal was noted in the mucous membrane of the mouth, and neither then nor subsequently was there any general eruption. The child's nutrition was fairly good. The case was treated with mercury, under the impression that it was syphilitic, and it seemed to improve. The sores on the eyelid and ear almost healed, but that on the arm remained unaltered, and "the mouth became very sore." About three weeks later the child was much worse, a large abscess formed on

[1] Case I., Appendix ix. to Final Report of Royal Commission on Vaccination; and evidence of Mr. Ward, Mr. Littlewood, and Dr. Barrs, Sixth Report of the R.C.V., Questions 23, 574-912; and Report by Mr. Hutchinson, *Archives of Surgery*, vol. i. p. 106.

the right buttock and another over the upper part of the sternum. The skin over these parts was implicated, and appeared about to slough. Death resulted at the end of the fourteenth week after vaccination. The post-mortem examination did not throw any light on the nature of the case. No lesions of the viscera or bones were discovered. The arguments against the view that this was a case of invaccinated syphilis are :—

(*a*) That the vaccine punctures began to inflame within a week ; (*b*) that they did not develop into chancres ; (*c*) that they did not cause any induration of glands ; (*d*) that there was no general secondary eruption ; (*e*) that the mother suckled the child and did not contract any sore upon the nipple ; (*f*) that the chronology of events was quite unlike that of vaccinal syphilis ; (*g*) that there was no evidence of syphilis in the vaccinifer ; (*h*) that none of the co-vaccinees suffered in a similar way.

In view of all these negative data, the only satisfactory way of demonstrating that such a case was one of invaccinated syphilis would be to show that there was a probability of contamination of the lymph or of the instruments used in the operation. No evidence of this kind was to be obtained ; so that the conclusion is justified that these, and similar cases, are erratic forms of necrosis following vaccinia, and are possibly due to sepsis, as cancrum oris and noma sometimes follow other acute febrile diseases, such as measles and varicella, without any ground for suspecting a syphilitic infection.

The following table is given for the sake of comparing the events in the case referred to with one of vaccinal syphilis, founded on those given by Prof. Fournier, *loc. cit.* p. 126 :—

[TABLE

	Vaccinal Syphilis.	E. M. C. Leeds Case.
Incubation .	Chancre never formed before 15th day, generally after 3 weeks. (Usually end of 4th or even 5th week—Hutchinson.)	First sign of inflammation on 6th day. Ulcers formed during 2nd week.
Development	By the 21st day ulceration in its earliest development, or not yet commenced.	Ulcers fully formed by 14th day.
Vesicles .	As a rule all the vesicles are not affected, vaccination often aborts.	All the vesicles affected.
Inflammation	As a rule slight.	Great.
Loss of substance	Less of substance superficial as a rule. Cf. Hutchinson, *Illustrations of Clinical Surgery*, 1878, pp. 121, 131.	Great. Vesicles sloughed into one large ulcer.
Discharge .	Scanty as a rule or absent. Generally forming scabs.	Considerable. Not drying into scabs.
Glands .	Enlargement always present, generally indolent, not inflammatory induration.	No induration of glands.
Secondary eruption	Roseolous eruption frequently present after formation of chancre, followed, at earliest 6 weeks later, by true syphilides.	None.
Tertiary symptoms	Gummata not generally present for many months after primary sore.	Large abscesses formed, surmised to be softening gummas, 12 weeks after vaccination.
History .	A history of syphilis in parents, vaccinifer, or co-vaccinees to be expected.	No history of syphilis in vaccinifer or co-vaccinees.

(ii.) *The differential diagnosis between vaccinal syphilis and the results of vaccination in a syphilitic child* in cases in which vaccination is either normal or abortive does not, as a rule, present any serious difficulty. But in those cases in which pus has been inoculated with the specific virus, or the pocks have been irritated and suppuration consequently set up, there may be some departure from the normal course of events.

I have recorded several important cases of this kind. In one the mother of the child had suffered severely from syphilis, and she had already lost one child from congenital disease. Her infant suffered after vaccination from severe inflammation round the pocks, which resulted in gangrene (see Case 202, App. ix. to Final Report R.C.V.) In another instance a child exhibited a general eruption during the first week after vaccination, and was shown at a London hospital two days later as a typical case of congenital syphilis: there was evidence to show that both parents had suffered from venereal disease (Case 326, App. ix. R.C.V.) Lastly, attention may be directed to Case 309, wherein, so far as can be ascertained, the vaccination pursued a normal course, and the child died

of symptoms of inherited disease; the history of the parents gave the strongest support to the view that this diagnosis was correct.

The chronological order and sequence of events in these or similar cases may be seen in the following table compiled from Fournier, Hutchinson and others, and compared with a case investigated by myself:—

Symptoms and Sequence of Events.	Hereditary Syphilis.	H. C. Report No. 207, p. 397.
Evolution .	Irregular. Commencing as a rule with general symptoms.	Irregular. Ulcer at seat of vaccination formed by 12th day. No induration of base. Ulcer healed in 6 weeks without specific treatment. Evidence of general infection at the end of 5th week.[1]
Rash . .	Rash papular and pustular, often chiefly on face. Roseola on abdomen not the rule. Rash and excoriation round nates and scrotum common.	Rash papular and pustular, chiefly on face, chest, and arms. Not preceded by any roseola on abdomen.
History .	Family history of syphilis important.	Grounds for suspecting syphilitic infection in both father and mother.
	It is almost unknown for a child suffering from hereditary syphilis to inoculate its mother.	Mother suckled child without infecting her nipple.

(iii.) *Differences between vaccinal ulceration and vaccinal chancre.*—Allusion has been frequently made to vaccinal ulceration; and though unquestionably it appears to occur at times in children not obviously cachectic, my own experience has been that it is mostly the result of some morbid condition—as in Case 202, in which the child was unquestionably of syphilitic parentage; or to some extraneous source of irritation—as in Case 144, where the wounds were treated with castor oil, with buttermilk applied with a feather, with brewer's yeast, and with bread poultices. It is in fact wonderful that severe ulceration does not more frequently occur. I have been shown a case with ulceration, considered suggestive of syphilis, in which the wounds had been treated with cream applied with a feather which was picked up in the back yard and which had been left unwashed in the cream for some weeks. In another case buttermilk was applied to a piece of rag and left adherent to the wounds for some three weeks without being changed. I have also seen cases in which the vaccination wounds had been scrubbed and irritated by the edge of the sleeve saturated with the pus and blood in which it had been soaked for many days. These instances might be multiplied; but those given sufficiently indicate the fallacies which beset the opinion

[1] Compare with table of symptoms in vaccinal syphilis on page 62.

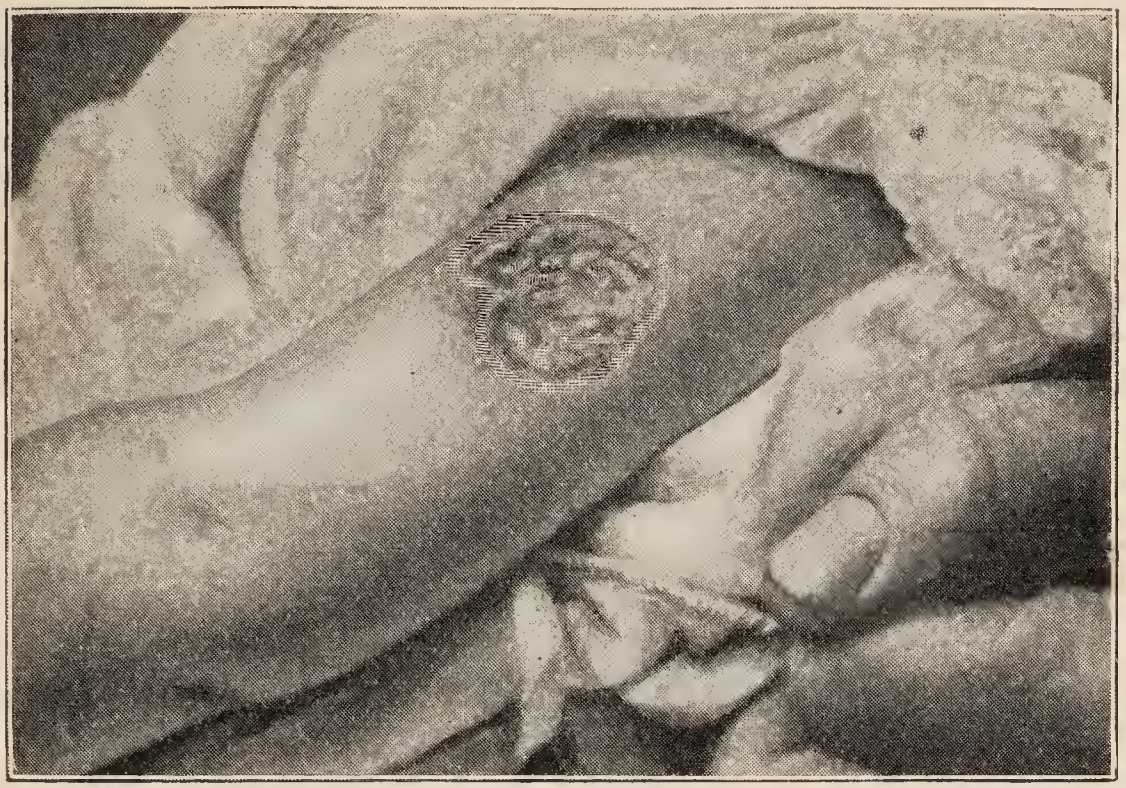

FIG. 8.—Vaccinal ulceration. From a photograph taken in the 2nd week after vaccination.

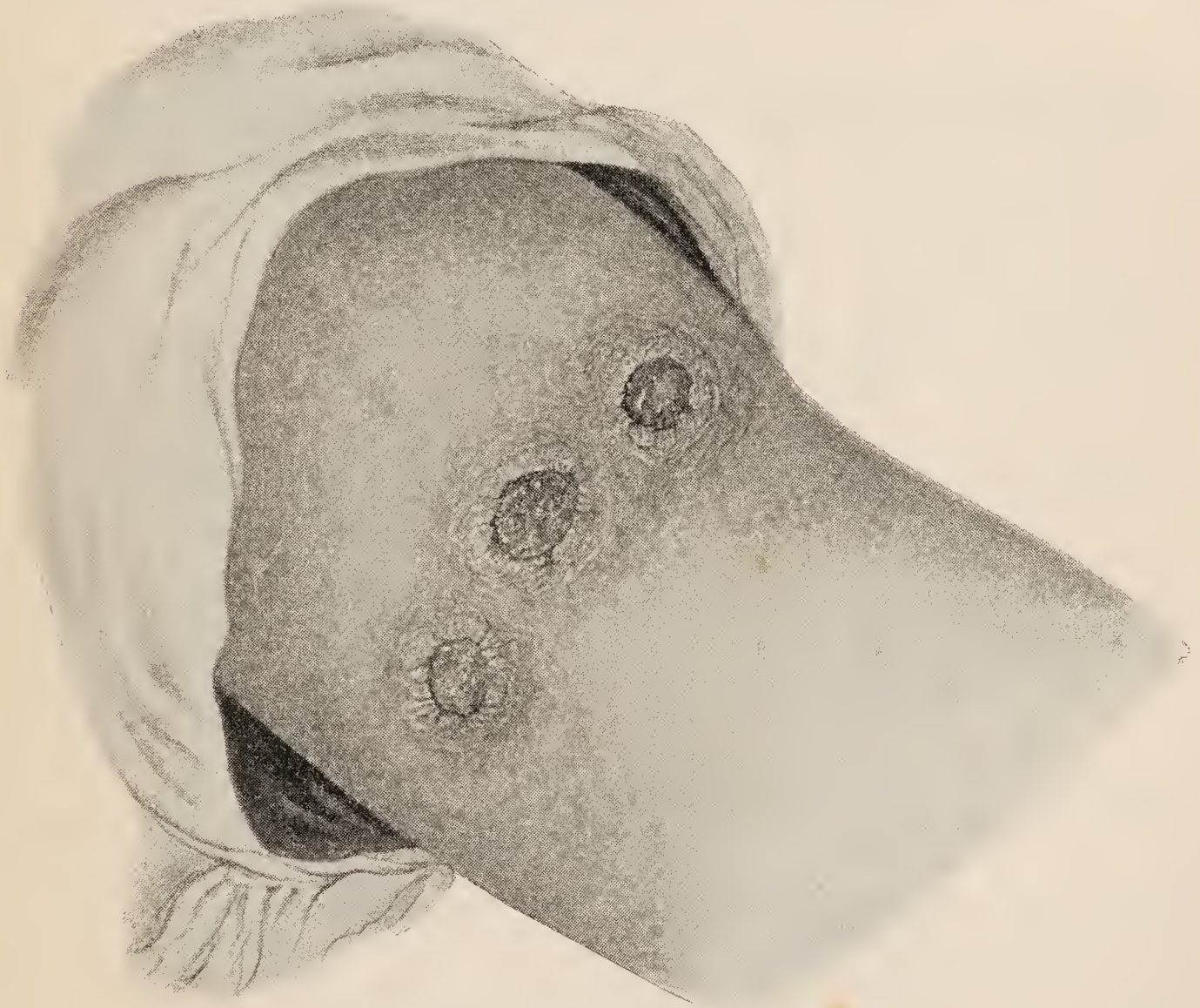

FIG. 9.—Vaccinal Syphilis. Reproduced from a drawing of Mr. Hutchinson's case, *Illustrations of Clinical Surgery*, plate xxiv. Three chancres are situated at the point of vaccination. The vaccinal pocks went through their normal stages and healed well before the chancres developed. The drawing was made two months after vaccination, when induration was just commencing.

that cases of vaccinal ulceration taken without knowing the circumstances are either suggestive of syphilis, or "are manifestations of cow-pox," or necessarily indicate any analogy between the two disorders.

The ordinary features of vaccinal ulceration (Fig. 8) are shown briefly in the following table taken from an actual case, and placed side by side with those which have usually been observed (17) in vaccinal syphilis (Fig. 9) :—

TABLE comparing Vaccinal Ulceration and Vaccinal Syphilis, with an actual case (see Figs. 8 and 9).

Generally observed Symptoms of Vaccinal Ulceration.	Case of J. W. P.	Vaccinal Syphilis.
1. THE ULCER		
Incubation . 12 to 15 days.	14 to 16 days.	Generally upwards of three weeks, never less than 15 days.
Development . Ulceration fully developed by 21st day.	Ulceration well marked by 16th day, at its height on the 25th day.	Ulceration in its earliest development, or not yet commenced, about 21st day.
Vesicles affected As a rule all vesicles affected.	All the vesicles (three) affected according to Dr. H. V.; one ulcer formed according to Mrs. P. the mother.	As a rule all vesicles not affected. Vaccination vesicles often abort.
Inflammation . Generally a prominent symptom.	Considerable.	As a rule slight.
Loss of substance Great. Ulcer generally deeply excavated.	Great. Ulcer deeply excavated.	Loss of substance, superficial with rare exceptions. Much less excavated than a vaccinal ulcer. (Compare a case which was "probably on the verge of phagedæna," *Illustrations of Clinical Surgery*, Jonathan Hutchinson, 1878, at pages 126 and 131).
Discharge . Considerable ; not drying into scabs.	Considerable ; not drying into scabs.	Scanty or absent, nearly always forming scabs.
Edges . . Punched out, perpendicular, irregular.	Punched out.	Not punched out, sloping to floor.
Bottom . . Uneven, unhealthy-looking, sometimes sloughy.	Unhealthy-looking.	Smooth, even.

TABLE comparing Vaccinal Ulceration and Vaccinal Syphilis—*continued.*

Generally observed Symptoms of Vaccinal Ulceration.		Case of J. W. P.	Vaccinal Syphilis.
Base . .	Inflammatory induration.	Inflammatory induration.	Induration circumscribed, elastic, parchment-like.
Areola . .	Extensive. Diffuse inflammation, lymphangitis, cellulitis, erysipelas, and other inflammatory complications common.	...	Very slight, often inappreciable.
	2. THE GLANDS		
Glands . .	Either no reaction or acute inflammation.	Not noticed to be enlarged.	Enlargement always present, indolent non-inflammatory induration.
	3. THE ERUPTION		
Development .	First appearance between the 9th and 15th days, always contemporaneous with vaccination.	First rash, red with some exudation noticed on 10th day after vaccination. Second rash, scaly, coppery, about 40th day.	At the earliest, appear first, 63 to 70 days after vaccination. (In Mr. Hutchinson's cases it varies from 42 to 63 days when untreated, and from five to seven months in those under mercurial treatment.—*Loc. cit.* p. 133.)
Relation to primary sore.	Not preceded by a typical vaccinal chancre.	Not preceded by a typical vaccinal chancre.	Always preceded by a chancre at the point of vaccination.
Clinical characters.	Of ordinary types (roseola, miliaria, bullæ, etc.); not lasting. No mucous tubercles.	No mucous tubercles.	Characteristic syphilides; persistent. Mucous tubercles often present.

Some further points of distinction between vaccinal and syphilitic eruptions will be found in detail on p. 11.

What I have stated above will have indicated some of the many sources of fallacy which have to be guarded against in the investigation of an alleged case of vaccinal syphilis; and the section on this subject cannot be better brought to a conclusion than by quoting the judicial statement made in the Final Report of the Royal Commission, 1896, p. 109, which is as follows:—

"The close resemblance in certain very rare cases of the results of vaccination, whether with calf lymph, or humanised lymph to those attributed to syphilis (a resemblance so close that it has caused in a few cases a difference of opinion whether the disease was syphilis or vaccinia), has led to the expression by Dr. Creighton of the opinion that there is some essential relationship between these two diseases. This, however, is a point of speculation almost it might be said of transcendental pathology upon which for practical purposes it is useless to enter. It must be sufficient to remark that, whatever may be the relationship alluded to, it exists, if it exists at all, equally between small-pox and syphilis as between vaccination and syphilis. For all practical purposes variola and vaccinia are both wholly distinct from syphilis, and their differences are, with the rarest exceptions, easily recognised. They are alike in being attended by affections of the skin and mucous membranes, and exceptionally by disease of the bones, eyes, and other parts, but in all these it is a question of resemblance and not of identity with which we have to deal."

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Part V

Vaccination in Relation to various Diseases

Vaccination and tubercle.—The question of the possibility of the transmission of tuberculosis by vaccination has received much

attention. M. Degive, at the Congrès pour l'étude de la Tuberculose, Paris, 1889, stated that it had been proved that the vaccine pustule could transmit tubercle; but no evidence was brought forward at the time in support of the assertion. When traced to its origin it was found to rest on an account given by M. Butel of some experiments performed by three Greek physicians, and on some well-known experiments made by M. Toussaint;[1] and not on any new facts brought to light by the speaker. The three Greek observers are stated to have inoculated two rabbits with lymph taken from a vaccine vesicle raised on a person suffering from "phthisis of the first degree." In one of the rabbits a tubercle was noticed at the point of inoculation at the end of twelve days, and after five weeks there was generalised tuberculosis. The author of these statements, in reply to my request for further particulars, expressed his regret that his notes were lost. M. Toussaint's experiments consisted in vaccinating a tuberculous cow on the vulva with lymph taken from a well-formed vaccine vesicle raised on a healthy child. On the seventh and eighth days—the pocks being then umbilicated—he took lymph and with it inoculated four rabbits, a pig, a cat, and a pigeon. Two of the rabbits were killed two months later, and were found to be suffering from tubercle at the point of inoculation, in the lungs, and in the lymphatic glands. The other two rabbits, killed just when they were going to die, were also tuberculous. The pig was killed 142 days after inoculation, and was found to be suffering from widely-distributed calcareous and caseous tuberculous nodules. The cat and the pigeon were killed on the sixtieth day and did not show any sign of tubercle.

These experiments are quoted because they are the only ones, so far as I am aware, which have been seriously advanced in support of the above statement made by M. Degive. They should be accepted with great reserve, as the sources of fallacy in their method are obvious. The first series, without more detail which unfortunately cannot now be given, can hardly be said to have any demonstrative value; the second series (M. Toussaint's) are inconclusive, as the vaccination was performed on a part which, if any tuberculous excreta were passed, could hardly fail to be contaminated. It may be pointed out that the cow selected was obviously tuberculous, and that experiments performed with lymph taken from the cow on the seventh and eighth days, and from vaccine vesicles in such a position and under such circumstances, can have little or no practical bearing on the transmission of tuberculosis in the ordinary course of vaccination.[2] If any further evidence were needed to show how little reliance can be placed on these experi-

[1] The original communication (14) was made in 1881: 'Note présenté à l'Académie des Sciences le 8 Août, 1881. Infection tuberculeuse par les liquides des sécrétions et par la sérosité des pustules de vaccin."

[2] In the Minority Report of the R.C.V., paragraph 219, p. 202, it is stated that "the experiments of M. Toussaint indicate the possibility of inoculating tubercle upon animals by vaccination" (reference being made to answer 22,714). But no new facts are brought forward.

ments in support of the allegation that there is in fact a substantial danger of inoculating tubercle with vaccination, it may be pointed out—

1. That vaccine lymph is obtained from calves and not from adult cows; and even if it were obtained from adult animals, those obviously tuberculous would not be selected for the purpose.

2. That calves are very little liable to tuberculosis. It is stated by Fürst (20), on the authority of Pfeiffer, that only one case of "perlsucht" occurred during the first four months of life amongst 34,400 calves; and these numbers are borne out by the statistics of the abbatoirs at Augsburg and Munich, only one tuberculous calf being found amongst 22,230 at the former place, and even less frequently at the latter (29). Yet this almost inappreciable source of danger can be avoided by the simple precaution of not using the lymph from any calf until the animal has been killed and proved to be entirely free from disease. Such, indeed, is the practice in some parts of Germany.

Besides those mentioned above, a large number of experimental inquiries have been undertaken to ascertain whether the lymph taken from vesicles of a person undoubtedly suffering from tuberculosis contains tubercle bacilli, or is capable of transmitting tubercle to susceptible animals. Amongst them may be mentioned those of Josserand, Acker, Lothar Meyer, Straus, and Peiper. MM. Josserand's and Straus's papers contain references to inoculation experiments, and Peiper's article contains references to a considerable number of cases of tubercle accidentally inoculated. None of these observers has been able to detect tubercle bacilli in the lymph raised on tuberculous vaccinifers (human or bovine); and none of the animals inoculated with the lymph taken from Straus's cases showed even a suspicion of tubercle after inoculation. In Josserand's cases the post-mortem examinations gave negative results in forty-three of the forty-seven animals inoculated; not one gave conclusive evidence of tuberculosis, and one only had enlargement of the glands in immediate relation to the point of inoculation. The lymph in these cases was obtained by vaccinating individuals obviously tuberculous; and, when thus obtained, it was used for inoculating the animals experimented on by injecting it into the peritoneal cavity, under the skin, or into the anterior chamber of the eye; so as to produce the maximum result. In fact the experiments were done in a manner which could not possibly have its counterpart in vaccination. Further, it is important to bear in mind that it is very difficult to obtain tuberculous infection by simple scratching of the skin; and this fact, which is in accordance with common experience, has received confirmation from Prof. Chauveau's (15, 9) experiments. He found that in five instances in which he endeavoured to produce tuberculosis by means of inoculation through the medium of the skin, not only were the results negative, but also no sign of tubercle was found in any of the scars. It is probable that in those cases of local tubercular inoculation which occur after tattooing, cuts, and the like, the wound has always penetrated the skin so that the infection took place in

the subcutaneous tissue. No undoubted case of invaccinated tubercle was brought before the Royal Commission on Vaccination; but Dr. Barlow has reported one case in which lesions, believed to be tuberculous, appeared in the skin of a child who had been vaccinated three months previously. The vaccination in this case pursued a normal course, and there were no tuberculous lesions affecting the vaccination sites or the lymphatic glands in the axilla on the same side as the vaccination. The child's father had died of some acute pulmonary disease of three months' duration, probably tuberculous.

A similar case is recorded by Marocco (26, 20). In this instance the child died of tuberculosis four months after being vaccinated with calf lymph. The pocks healed well, and subsequently disseminated red papules appeared; these suppurated, and caseous abscesses formed round the joints. No details are given of previous or family histories, so that this may have been no more than one of those coincidences which must occasionally occur after vaccination, without any causal relations between the operation and the subsequent event.[1]

I have seen only one case of death from acute miliary tuberculosis in an infant within the first few weeks after vaccination: in this case (No. 207, Appendix ix. to the Final Report of R.C.V., p. 397) the wounds healed completely, and about twelve weeks after vaccination the child died of acute miliary tuberculosis. The post-mortem examination showed that there was no induration in or around the vaccination scars, which were well and firmly healed; nor was there any enlargement of the axillary or cervical glands. There was, in fact, nothing in the condition of the scars, or of the glands in relation with them, to suggest that the vaccination and the tuberculosis were in any way connected.

From the facts which up to the present time have been brought to light, it would seem to be certain that the communication of tuberculosis in the course of vaccination is of such exceeding rarity that it is even doubtful whether it has ever been so transmitted. This latter conclusion has been arrived at by many observers both on practical and scientific grounds. Bollinger goes so far as to say that the inoculation of tuberculosis in vaccination is to be denied absolutely; and Dr. Heron, who has paid great attention to the question of the transmissibility of tuberculosis from one individual to another, informs me that he does not know of any recorded case in which the transmission of tubercle or lupus could rightly be attributed to vaccination.

[1] In the Minority Report R.C.V. 1895, paragraph 219, p. 202, it is stated that "it has been found that tuberculous disease can be readily conveyed from infected animals to healthy animals or persons by the medium of infected animal-products such as milk." Although under certain circumstances this statement is correct, it has little or no direct bearing on vaccination. Tubercle bacilli have never yet been detected in vaccine lymph, even when raised on tuberculous individuals (such as could not possibly be selected as vaccinifers). And, further, the milk of tuberculous cows is only known to be infective when there is local tuberculous disease in the mammary gland. There is no evidence to show that the milk of tuberculous individuals in whom the gland is healthy either contains tubercle bacilli or is capable of communicating the disease. This opinion is shared by Dr. Sidney Martin, to whom I am indebted for information on the subject.

Vaccination and lupus.—Lupus affecting the seat of vaccination has been observed in some few instances; but it is much to be regretted that in none of the recorded cases with which I am acquainted has it been possible to determine with anything approaching to certainty whether the disease was invaccinated, or whether the case was merely an ordinary lupus attacking the vaccination scar; or even to show whether the lymph came from a contaminated source, or was presumably capable of exciting any but the specific effects of vaccination. Mr. Hutchinson (21) and M. Vidal (10) are of opinion that, in the cases recorded, there is no sufficient ground for believing that lupus resulted directly from vaccination, but that it was due to the patient's constitutional tendencies. There is some justification for this opinion; but there is no evidence to show that lupus itself can be transferred by inoculation from one person to another. M. Vidal, indeed, states that his numerous attempts to accomplish it have failed.

Dr. T. C. Fox informs me that he has seen a case in which lupus began in one of the vaccination scars shortly after the sore had healed. Subperiosteal tuberculous nodules, with a disseminated lupus, afterwards appeared; and after death it was found that the child was suffering from pulmonary tuberculosis. There is no record in this case of the source of lymph; and, as one other child in the same family died of tuberculosis, it is possible that this child was already tuberculous at the time of vaccination, and that the operation acted merely as the exciting cause of the acute disease: this often happens in children after the exanthems, and even after mechanical injuries. In the only case of post-vaccinal lupus, which I have myself seen and investigated ((2) and cf. Sixth Report of R.C.V., p. 141), the evidence was very inconclusive. The child was vaccinated in four places, two of the vaccination wounds did not heal completely, and two are stated not to have healed for two years; the lupus from which the child afterwards suffered is believed to have originated in one of the scars; and when the case was first seen five years later, the whole of the vaccinated area was involved (see Fig. 10). This child was the second of six children, and no member of the family was known to be tuberculous. The source of the lymph could not be traced. Cases reported by Lenander and Besnier are not more conclusive. The one was seen eighteen years after vaccination; the other more than thirty-four years afterwards. In Lenander's case vaccination is said to have been normal; and though lupus had commenced in the scar, and there was a small ulcer when the boy was ten years old, a doctor was not consulted about it until he was seventeen. When first seen by Lenander, the appearances of the original sore had been much altered by treatment; but the case was proved, on microscopic examination, to be tuberculous. No conclusion seems to be warranted from these cases, except that lupus may attack a vaccination scar, as it may attack any cicatrix; and, even supposing the local lesion to have no causal relation with vaccination, it is remarkable, seeing how frequently lupus occurs, that there are not more cases on record,

similar to those given above, in which the disease had attacked the scars.

Vaccination and "scrofula."—The further question arises whether vaccination be in any way responsible for the production of the chronic tuberculous diseases which are included under the names tabes mesenterica and scrofula. The number of children amongst the labouring classes who suffer from these complaints makes it certain that some infants will sicken and die of them within a few weeks or months of vaccination; and, although vaccination may be in no way the cause of the disease, it may and must always be difficult in such cases rightly to apportion the precise effect of inheritance, circumstances, and vaccination: especially if, owing to feeble health, degenerate

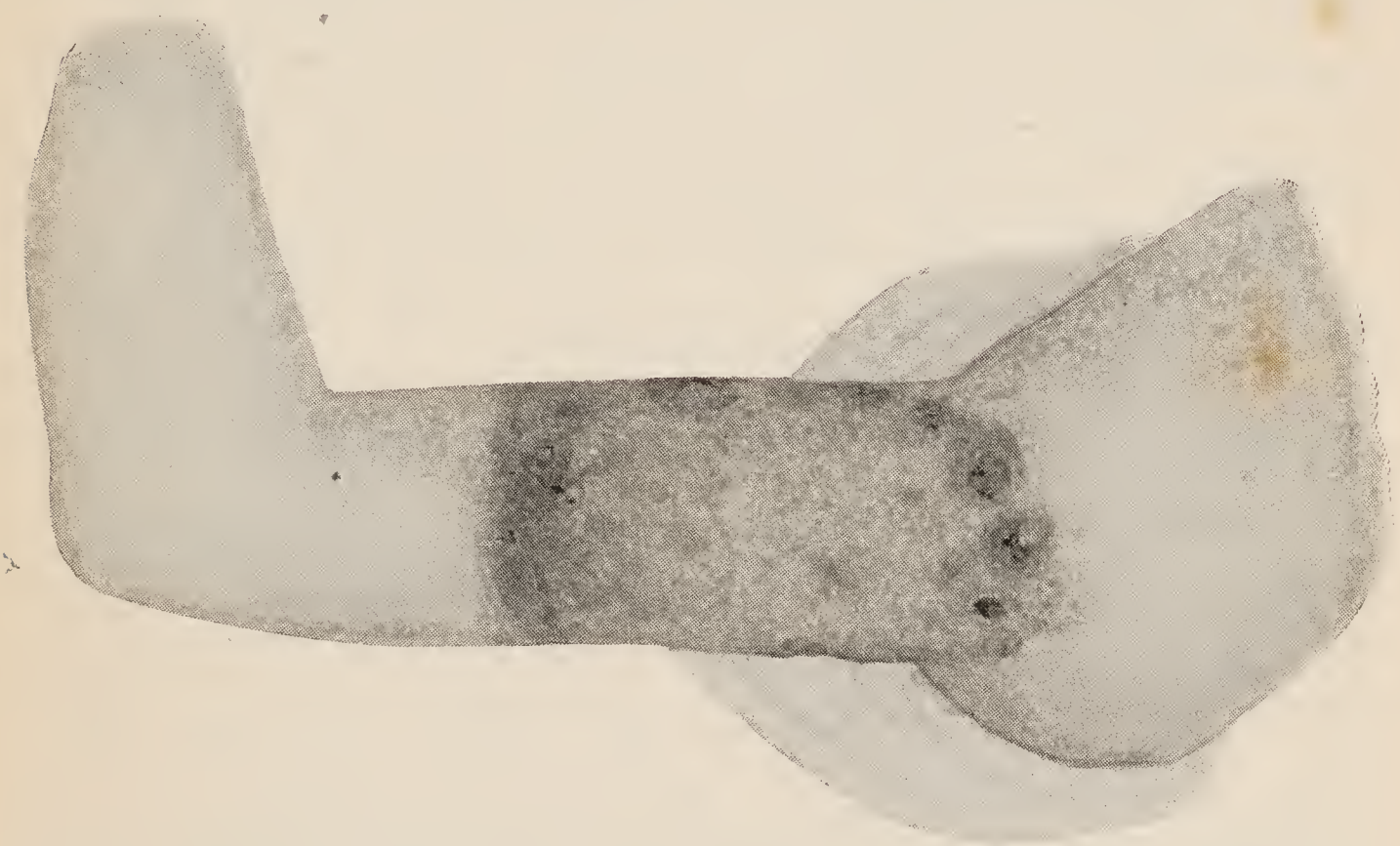

FIG. 10.—Lupus affecting the seat of vaccination. Drawn 9 years after the operation. For details of the case see p. 68, and Case 26, p. 242, Appendix ix. to Final Report R.C.V. 1896.

tissues, and bad surroundings, vaccination has been followed by ulceration, glandular abscess, or some such complication likely to excite febrile disturbance. A long inquiry into such a case will be found on p. 374, App. to Final Report R.C.V. 1896. Further, the length of time necessary for the evolution of the disease is so protracted that the all-powerful factors of inheritance, circumstances, food, clothing, and so forth, which exert their influence on the lives of all infants, have full time to make themselves felt, and to render it practically impossible to draw sound conclusions from individual cases. In order, then, that some estimate may be made of the effect of vaccination on the prevalence of the diseases named, a wider survey must be taken. During the last forty years the Registrar-General's returns have shown an increase in the number of deaths ascribed to tabes mesenterica and scrofula, and a decrease in the allied diseases of hydrocephalus and

phthisis. How much of this is due to better diagnosis and to transference of cases from one class to another it is impossible to say; but that the increase is not due to vaccination may be inferred from the Leicester statistics, which prove to be a useful standard for comparison. In Leicester the increase in deaths from tabes mesenterica and scrofula during 1883-87, as compared with the years 1863-67, has been 25·8 per cent; the increase for England and Wales during the same period is 26·8 per cent; from this it may be inferred that, within reasonable limits of error, Leicester is, in this respect, as badly off without vaccination as the rest of England is with it. In the opinion of those best qualified to judge, the facts brought before the Vaccination Commission do not warrant the assertion that the increased mortality from the diseases under consideration is in any way due to vaccination (18).

Vaccination and leprosy.—It has often been asserted that leprosy can be, and has been, spread by vaccination; and some few individual cases have been brought forward as evidence in favour of the view. To determine whether this is possible it must be shown:—

1. That leprosy can be communicated directly by inoculation.

2. That leprosy bacilli can be detected in vaccine vesicles raised on a leper at the place where the skin is healthy.

3. That individual cases have been observed in which, from the evidence, there is good ground for believing that leprosy has been accidentally invaccinated.

The evidence on the first point, namely, the general question of the communicability of leprosy directly from one individual to another, is conflicting and contradictory. A case recorded by Dr. Hawtrey Benson (8) is important as giving ground for the suspicion that under exceptional circumstances the disease may be so communicated. In this instance, two brothers lived and slept together; one had contracted leprosy in the "Indies." He died, and three years later his brother, who had never been out of the United Kingdom but had worn his clothes, showed symptoms of the disease. This case is far more convincing than those which occur in countries where leprosy is endemic; though it does not justify any deduction as to the reality of the alleged danger of communicating the disease by vaccination. So far as the evidence goes at present it must be considered extremely doubtful whether the disease has ever been communicated directly or indirectly in the ordinary course of this operation.[1] Notwithstanding all that has been said by those who are of opinion that the increase in leprosy, which has occurred in some of the places where the disease is endemic, is largely due to vaccination, not one case in which there was any sufficient evidence to justify such a

[1] The whole question will be found fully discussed from the scientific point of view in the *Journal of the Leprosy Investigation Committee*, i. 5-11, 130, 141; iii. 90; iv. 32-41, 72, and from the opposite side, in the *Recrudescence of Leprosy and its Causation*, by W. Tebb. London, 1889. See also Beavan Rake, *Medical Record*, New York, 1893, vol. xliv. p. 705, and *Report on Leprosy for the year* 1892, Trinidad, 1893. Also Phineas Abraham, *Trans. VII. Internat. Congr. of Hygiene*, London, 1892, vol. i. p. 384; and in the present volume of this *System*, p. 41.

statement was brought before the Royal Commission of 1889-96. On the contrary, those who have had the widest experience and the best opportunities of forming a correct judgment—such men as Dr. Hansen of Bergen, and Dr. Beavan Rake, medical superintendent of the Leper Asylum at Trinidad—do not consider that any such inference can be drawn from the data which are available. These opinions, weighty in themselves, are supported by the fact that in New Zealand, Iceland, Norway, and India, leprosy has steadily declined (19), although vaccination has been widely practised; while in the Sandwich Islands it has at the same time largely increased. Dr. Hansen has never seen a case of invaccinated leprosy; he informs me that in 1890 he sent out a circular to all physicians in Norway, asking whether they had observed any case of leprosy occasioned by vaccination. This inquiry failed to trace a single case in which there was ground for believing that leprosy had been so caused. The importance of such a statement is obvious when it is remembered that vaccination is efficiently carried on throughout the country.

To prove that there is *prima facie* ground for believing that leprosy may be invaccinated, reference has been frequently made to the following experiments made by Arning (3, 4). He inoculated the left forearm of a native Hawaiian with a portion of leprous nodule; a month later the man suffered from pain in the left shoulder, elbow, and wrist, with painful swelling of the ulnar and median nerves. During the next six months the neuritis gradually subsided and a small leprous nodule formed at the point of inoculation. Leprosy bacilli were present for six months. Two and a half years later the symptoms of leprosy were definite; and a year afterwards the disease was at its height. The fallacy of drawing any deduction from such a case, to prove the danger of inoculating leprosy by vaccination, is too obvious to need comment; for, apart from the fact that vaccination does not consist in inoculation with leprous tissue or cultures of leprosy bacilli, the man came of a leprous family, and lived in a place where leprosy was endemic. Even Dr. Arning himself does not appear to consider that the case proves conclusively that leprosy was inoculated.

Inoculation experiments have been made by other competent observers, especially by Danielssen and Hansen; but the results were entirely negative.

Arning (5) detected leprosy bacilli in the lymph of vaccination vesicles raised on the skin of an advanced case of tubercular leprosy; but he did not detect any in lymph from two cases of anæsthetic leprosy. On the other hand, Beavan Rake (7) and Buckmaster (24) examined a large number of cases in a similar manner, and in most cases did not find any trace of bacilli. In the cases in which the part vaccinated was obviously diseased they found suspicious-looking rod-like bodies; but, as Beavan Rake states, even if the doubtful cases be admitted as evidence that leprosy bacilli are to be found in a vaccine vesicle raised on a patch of tuberculous leprosy, it has no bearing on the question at issue; since no responsible person would think of vaccinating a leper in an affected part, and using lymph from vesicles so obtained for further vaccinations.

The conclusions these observers arrived at are as follows :—

1. That the alleged cases of transmission of leprosy by vaccination are open to serious doubt.

2. That, assuming the presence of leprosy bacilli to be necessary to produce leprosy, no danger need be apprehended from the vaccine lymph even of an actual leper ; provided he be vaccinated on healthy skin.

Turning from the experimental to the practical side of the question the evidence is even less precise and conclusive. Two series of cases have been repeatedly quoted as giving some ground for the suspicion that leprosy might be communicated in the ordinary process of vaccination. The first of these cases was recorded by Prof. Gairdner[1] and is as follows :—

Dr. X., living in a tropical island where leprosy was endemic, vaccinated his own son from a native child, and from his own boy in turn vaccinated a third child. Both the latter in after-years suffered from leprosy. The native child was said to have come of a leprous family, and Dr. Gairdner writes that he "understood (though perhaps not definitely so stated) that leprosy had declared itself in the native child after vaccination" ; of this fact, however, there was so much uncertainty that in a subsequent letter to the *British Medical Journal* (13) he modified this statement, and says that the doctor's child was vaccinated from a native child who was "probably not an actual or apparent leper." Thus in this much-quoted case there is no evidence that the children, who some years later became lepers, were in fact vaccinated from a child suffering at the time from leprosy. Neither is it known that the latter subsequently became a leper. Again, there is no information as to the date or situation of the first appearance of the leprosy ; and during the time which intervened between vaccination and the development of the disease the children appear to have been living in a country in which leprosy was endemic. So much attention would not be called to this case were it not that it has been almost invariably quoted as one in which the two boys who suffered from leprosy had been vaccinated from a native child who afterwards became leprous ;[2] and much greater weight has been attached to it on this account than it rightly deserves.[3] The other classical cases are reported by Daubler (16).

Two women were vaccinated from a patient who subsequently died of

[1] "A Remarkable Experience concerning Leprosy," etc., *British Medical Journal*, vol. i. 1887, p. 1269. I have made every effort to trace the vaccinifer in this case, as it is one not only of scientific but of practical interest. Dr. X. is dead : Mr. Racker, who wrote to Mr. Tebb (30) saying that he knew all about the case, gave the wrong initials for the father and the wrong name for the school at which the boy had been, so that his statement requires confirmation : neither Dr. Gairdner, Dr. Buckmaster, Dr. Beavan Rake, nor Mr. W. Tebb know more of the case than stated above. I have not yet received any reply to the inquiries I have addressed to Mr. Racker and Dr. Pasley, who both speak as though they were acquainted with the circumstances.—T. D. A.

[2] Cf. Beavan Rake and Buckmaster, *Journal of Leprosy Investigation Committee*, No. 4, p. 32 ; *Report of Leprosy Commission in India*, Appendix I. p. 414 ; Beavan Rake, *Medical Record*, New York, *loc. cit.* p. 708 ; Phineas Abraham, *loc. cit.* p. 6, and many foreign periodicals and monographs.

[3] Cf. C. F. Carter, *Leprosy and Vaccination in British Guiana ; Journal of Leprosy Investigation Committee*, No. 4, p. 39 ; and Phineas Abraham, *loc. cit.* p. 3, note.

tuberculated leprosy. In both instances leprous tubercles first appeared on the forehead and cheeks; in the one case eighteen weeks, and in the other about eight weeks after vaccination. They were not seen by Daubler until some years later (probably about $3\frac{1}{2}$); and there is no evidence to show that the vaccinifer was leprous at the time when vaccination was performed: nor in either case was there any evidence that the disease began in the vaccination scars, or subsequently affected them. It is worthy of note that leprosy appeared in both cases in less than five months; and Dr. Beavan Rake remarks that clinical experience does not warrant the belief that a disease so essentially chronic as leprosy is produced so soon after inoculation. Other similar examples might be given; but the above will suffice to show that it is doubtful whether leprosy can be inoculated even under exceptional circumstances. Should this possibility, however, be proved, the disease could hardly be inoculated under the conditions which occur in vaccination; since, apart from the fact that a person suffering from leprosy or coming of a leprous family would not under any circumstances be used as a vaccinifer, there is ground for believing that vesicles developed on healthy skin do not contain the specific virus capable of communicating leprosy.

Vaccination and cancer.[1]—There is no authentic case on record in which cancer has resulted from vaccination; neither have I seen nor been able to trace any case of cancer affecting the vaccination scar. No mention would be made of the subject, were not cancer one of the diseases the increase of which has been attributed to vaccination (32).

Apart from this clinical evidence, which is very strong, the statistical evidence is still stronger; as may be seen from the following facts:—

1. The mortality from cancer during each quinquennial period of the first fifteen years of life has decreased.[2]

2. The increased mortality from cancer is greatest at the period of life furthest removed from vaccination.

3. The whole of the recorded increase in cancer has taken place in inaccessible cancer; that is, under circumstances in which exact diagnosis is difficult.

4. There has been practically no increase of cancer in accessible parts.

The whole subject has been ably worked out by Mr. George King, actuary of the London Life Office, and Dr. Arthur Newsholme (28); who, after examining all the evidence, draw the conclusion that the increase in cancer is apparent only, and is due to improvement in diagnosis and more careful certification of the causes of death.

Vaccination and epizootic disease.—No case of epizootic disease resulting from vaccination, or associated with it, has, so far as I am aware,

[1] Objection may be raised to the use of the word "cancer" as too vague. It is the term used by Mr. A. R. Wallace. Here it is not restricted to its technical meaning, but includes all forms of neoplasm.

[2] Final Report R.C.V., par. 391, p. 102.

been recorded in this country. Three cases of aphthous stomatitis occurring during the vaccination period, and in many ways resembling aphtha epizootica (foot-and-mouth disease), came under the observation of Dr. L. Voigt (31) of Hamburg; but inasmuch as many similar cases occurred in the neighbourhood, and there was also an outbreak of the affection amongst the cattle, there does not seem to be any ground for supposing that its occurrence in the vaccinated children was anything more than a coincidence: of the three children mentioned one had temporary discomfort, a second died of cholera with its father, and one only was seriously ill from the symptoms in question. This child suffered severely with high fever, stomatitis affecting the lips, tongue, and gums; the attack began on the tenth day after vaccination. A dusky papular eruption, which subsequently caused much irritation, appeared first on the lips, cheeks, and genitals; later it spread over the whole body, and ended in a severe folliculitis: this was complicated by bronchopneumonia. The child eventually recovered, vaccination having pursued a normal course.

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Part VI

Conclusion [1]

General considerations.—The foregoing pages have shown that the danger from vaccination, as at present practised in the United Kingdom, is in individual cases very small; from invaccinated disease it is almost nil: and although in a fractional percentage of cases grave complications arise, in almost every instance they are due to inflammatory or septic affections such as are common to all wounds, and are found to depend far more on various extraneous circumstances than on any properties inherent in the lymph itself. Serious results, the direct consequence of constitutional affections such as generalised vaccinia, or of cutaneous eruptions such as impetigo or eczema, will probably continue to occur in some few cases from causes which cannot at present be foreseen; but, as has been shown, they are exceptional and their number small.

Children after vaccination are at all times liable to suffer from various harmless rashes of an erythematous or urticarial type, which, though for the most part free from danger, not infrequently give rise to considerable distress. Children are peculiarly liable to such eruptions from any cause which produces local irritation or disturbance of the digestive system. It is unlikely that any precautions in the selection of lymph would materially lessen the number of such cases; but it is essential that those who have the care of vaccinated children should be scrupulously exact after the operation in avoiding all extraneous sources of irritation to the wounds, more especially in those children who are known to be liable to eczema or other eruptions. If the instructions to public vaccinators under contract issued by the Local Government Board (1888) are carried out in the spirit as well as in the letter,—if the child be healthy, its circumstances wholesome, the lymph carefully selected and properly used, and if reasonable care be exercised after vaccination,—there is no doubt that the dangers of the operation are extremely small.

The various sources of risk, and the safeguards which they suggest, may be considered under the following headings:—The child and its circumstances; the treatment of the arm; the lymph, and methods of storing it; the vaccinator, and methods of vaccination.

The Child.—*Age.*—Although there is good ground for believing that under favourable conditions vaccination may be carried out successfully on infants of a few days old, the custom in some infirmaries and lying-in institutions of vaccinating children shortly after birth is not infrequently productive of dangerous complications; and the practice [2] is to be discouraged except at times when there is danger from small-

[1] This section is largely founded on a memorandum prepared by Dr. Barlow and myself for the Royal Commission on Vaccination 1896; and reference is frequently made to the recommendations of the Commission, *q.v.* Final Report R.C.V. pp. 113-116.

[2] Final Report R.C.V. p. 115, par. 441.

pox: in this case the infant should, if possible, be kept under observation until the arm is healed.

There are two obvious sources of danger in vaccinating very young infants.

i. A considerable number of the children born in our workhouses, infirmaries, and lying-in charities are born under circumstances which entail distress and disgrace on the mother; consequently they are often feeble, and sometimes diseased.

ii. The mother may take her discharge and leave the institution just at the time when the child's arm is most inflamed; thus she may return to conditions of life which cannot fail to be harmful to the child.

If, on account of the prevalence of small-pox, it be necessary to vaccinate newly-born children, it is unreasonable and probably harmful to vaccinate in four or five places[1]—to give, that is, the same dose of the virus to a newly-born infant as would be given to an adult man; such a procedure is contrary to sound principles of therapeutics. Yet it may be inadvisable that a child, vaccinated in one place only, should receive a certificate of successful vaccination; and a parent, whose infant was thus vaccinated, might be required to have it vaccinated fully at the expiration of a year from the first operation.

Previous health of child.—In many cases which I have inquired into, the child, previous to its vaccination, had been suffering from some ailment which could not fail to affect its general health. Among these may be mentioned convulsions, diarrhœa and vomiting, scrofulous glands, eczema, and so forth. Again in several cases the child had just been weaned, or put on some new kind of food, fed on unsuitable food, or fed insufficiently. The vaccination of such children is contrary to the regulations issued by the Local Government Board. Care must be taken to select children for vaccination; and not to perform the operation, as sometimes is the case, on children who are obviously unfit. If the time limit for vaccination be extended to six months it will give vaccinators more freedom in this selection, and enable them to defer the operation in cases in which the child's health is uncertain.

Circumstances.[2]—There is considerable risk (*a*) in bringing children to be vaccinated from houses in which there are cases of acute infectious disease: (*b*) in bringing them at the time of vaccination into direct or indirect contact with infectious disease: (*c*) in exposing them to possible infection from sloughing or open wounds, purulent ophthalmia, or discharges of any kind: (*d*) in subjecting them after vaccination to unhealthy conditions such as result from gross sanitary defects. Cases of vaccinal injury resulting presumably from each of these causes have been investigated and recorded. No open wound would be expected to pursue a normal course under such conditions; but persons responsible for the care of children among the poor often, from ignorance or negligence, disregard the most ordinary precautions.

[1] Final Report R.C.V. p. 115, par. 441.
[2] *Ibid.* par. 445.

It is desirable that simple instructions on these essential points should be given to every person who brings a child to be vaccinated; and that the form of such instruction should not be left, as it is at present, to the individual vaccinator. Some public vaccinators give careful instructions, as a matter of routine; but the practice is not general.

Attention should be called to the fact that whereas inquiries were made for the Commission into cases of alleged vaccinal injuries in all parts of England, not a single case amongst the well-to-do classes has come under the notice of Dr. Barlow or myself. With few exceptions the cases of injury have occurred amongst the poor and ill-fed, living under conditions so insanitary that it is well-nigh impossible that the children could be healthy. In this class the lives of infants are exposed to far greater dangers than in the wealthier classes; and even a trivial operation such as vaccination must be attended with a certain amount of risk, the risk being dependent far more on the condition of the child than on the nature and normal effects of the operation. For this reason, among others, it is desirable to discourage the practice of very early vaccination, and to extend the age limit from three to six months; so that weakly infants may have had time to grow more vigorous, and inherited disease, if any, will have had time to declare itself.

Treatment of the arm.—*Treatment of insertions.*—Risk is often incurred by parents who, in the desire to lessen the severity of vaccination, wipe the lymph off the arm without due regard to the manner in which this is done; dirty fingers or dirty pocket-handkerchiefs are used, and the result often is irritation of the parts, excessive inflammation, glandular abscess, or some septic complication.

Treatment of vesicles.—One of the most frequent causes of vaccinal injury is due to the ignorance of the parents, and their disregard of the most elementary rules of cleanliness. Considering the variety of decomposable substances which are applied to the vaccination vesicles, and in a manner well calculated to accelerate decomposition, it is remarkable that the harm done is not greater than it is (cf. Vaccinal Ulceration, p. 60). It cannot be doubted that so long as such ignorance prevails as to the importance of cleanliness and the avoidance of mechanical irritation of the wounds, cases of injury will occur from time to time. The only way to combat these dangers is to instruct the parents in the care and treatment of the child before and after vaccination.

Shields.—It is probable that in many cases severe inflammation is caused, or certainly aggravated, by the use of shields. The shield is apt to rub the scabs off the vesicles and to produce an open sore. This danger is further aggravated when these shields are foul with pus from old vaccination wounds, as they not infrequently are kept and used for one child after another without being cleansed. In all cases the use of shields should be discouraged.

Dirty sleeves.—A similar source of danger is that of allowing a pus-soaked sleeve to rub into and irritate the vaccinal wounds.

Ulceration and suppuration frequently arise from this easily removable cause.

Opening of vesicles.—As has been pointed out, the majority of cases of erysipelas occur after the first week; but I am not able to produce definite proof that the risk of inflammatory complications is increased if the vesicles are carefully opened. It would seem, however, to be desirable that this should be avoided as far as possible.

Inspection of arm.—Great hardship is sometimes inflicted by requiring parents, under a penalty of a fine, to bring their children on the eighth day for inspection. I have seen children brought to the vaccination station in driving snow and bitter wind, just at a time when they should have been kept warm and well protected. Such exposure is a serious element of risk. If the age limit were extended to six months, and the obligation for inspection removed, it would be possible for children to be vaccinated during the warmer months only, and the vaccinator would be able to excuse attendance on the eighth day at his discretion; or it might possibly be arranged for the vaccinator during the winter to inspect the children at their own homes.

The Lymph and method of storing.—*The Lymph.*—In a small proportion of cases the lymph has been found primarily and directly responsible for vaccinal injury. In these cases the fault generally lies in the application or use of the lymph. Certain exceptional cases have, however, occurred in which, although as far as could be ascertained the lymph was normal, some abnormal result—such as generalised vaccinia—has followed its use.

Sources and preparation.—It has not been possible to determine with any precision the relative frequency with which complications have followed the use of calf or of humanised lymph, or the use of lymph stored on points, in tubes, or as a conserve. Abnormal results occasionally follow the use of each of them; but as there has been no possibility of determining the total number of vaccinations performed in each way, there are no data for ascertaining the relative results of the several methods respectively.

The general impression left upon me by my inquiries is that vaccination direct from the calf tends to produce more severe inflammatory reaction than that which has been humanised; although there is no reason to believe that serious inflammatory or septic complications follow its use more frequently than they do the use of humanised lymph.

There is a widely-spread desire for an increased supply of calf lymph, and the desire seems to be a reasonable one. The existing Institution for the gratuitous supply of calf lymph is on too small a scale to meet the demands made upon it; and, vaccination being compulsory, it has been recommended by the Royal Commission on Vaccination that steps should be taken to provide an adequate supply of calf lymph for the use of those who prefer it.[1]

[1] Final Report R.C.V. p. 113, par. 437. This recommendation will probably be very shortly carried into effect.

Storage of lymph.—From a theoretical point of view the storage of lymph in a dry state has doubtless great advantages; but in practice it is found less satisfactory than storage in tubes. Points may be dried without adequate protection in the dust-laden atmosphere of a crowded waiting-room; or carried about in the pocket merely wrapped in a piece of paper; or after use they may be recharged and used again without proper cleansing and disinfection. It seems, therefore, that the theoretical advantages of points are more than counterbalanced by the practical objections.

The storage of lymph, treated with glycerine, in tubes [1]—each tube containing only sufficient lymph for one vaccination—is probably the method least open to objection. It is of practical importance that only sufficient lymph for one vaccination should be contained in each tube, as serious results sometimes occur from the use of a tube of lymph which had been opened for a previous vaccination.

Vaccination and the vaccinator.—*Methods of vaccination.*—Cases of severe inflammation, abscess, erysipelas and septic infection have been known to follow the use of some mechanical vaccinator, or of the Cooper Rose needle. With adequate sterilisation such mechanical contrivances to shorten the process of vaccination would do no harm, and might serve a useful purpose; but they do not and hardly can receive the vigilant attention which is required to keep them surgically clean. Their use should therefore be strongly condemned; and attention should be called to the fact that it is essential that instruments used in vaccination should be as carefully sterilised as for any other operation. Nothing but an ordinary lancet or needle should be used, and the instrument should be much more thoroughly sterilised than is now frequently the case; preferably by immersion in some antiseptic or in boiling water, and by wiping each time, after use, on a fresh piece of sterilised wool.

Postponement of vaccination.—In all cases in which vaccination has been postponed it is desirable that a certificate, stating the causes of postponement, should be produced at the time when the child is subsequently vaccinated; so that the risk of taking lymph from the vesicles of a child known to be unhealthy may be rigidly excluded.

Position of pocks.—Ulceration not infrequently results from placing the insertions so near together that the vitality of the tissues between them is destroyed, and a slough is produced. This risk is easily obviated by not putting the insertions too close together, and by not making as many as four insertions in very young infants in whom the space is more limited.

Repeated vaccination.—In a few cases there is ground for believing that harm has resulted from repeating vaccination in a child a week after the first attempt, when the first vaccination had proved unsuccessful. It appears desirable that vaccination should not be repeated

[1] Cf. evidence before the R. C. on Vaccination by Dr. Copeman, and *Jour. of Pathology and Bact.* May 1894.

until at least four weeks have elapsed since the date of the first insertion.

Vaccination stations.—The use of surgeries as public vaccination stations should be discouraged, the performance of vaccinations in places to which every kind of infectious disease is admitted being of necessity fraught with considerable risk to the infants.

Certificates of vaccination.—There seems to be a certain amount of hardship involved in the fact that in the case of a private patient a certificate of successful vaccination may be, and sometimes is, given for a result which would not be accepted, and rightly so, by a public vaccinator. Instances occur in which a certificate of successful vaccination has been given by a private practitioner for one insertion; whereas four insertions would be made by the public vaccinator. It is obvious from this that a certificate of successful vaccination has no definite meaning, and does not necessarily show that a child has been properly vaccinated. It is desirable that every certificate of vaccination should specify the number of successful insertions.

Public vaccinators.—A general impression prevails that it is no part of the duty of a public vaccinator to attend to a child in case of any serious consequences of vaccination; at the same time some vaccinators gratuitously devote a large amount of time and care to a child suffering from some vaccinal complication, although they themselves are entirely free from any blame in the matter. It seems reasonable that it should be part of the duty of the vaccinator to attend any child who may be suffering from the results of the operation; but also that he should receive suitable remuneration for so doing. The fee which he receives for the operation cannot be considered as adequate remuneration for attendance on a child, it may be, for two or three weeks.

District nursing in regard to vaccination.—In populous districts, and in places where the services of a trained nurse are available, great benefit might result from having a competent person to act under the direction of the vaccinator, and to visit at regular intervals such cases as at the first inspection might be found abnormal. Many cases of the inflammatory kind might be quickly relieved by boracic lint, fomentations, or simple antiseptic methods properly applied. Moreover, a trained nurse might render material service in instructing the poor in due cleanliness, and in the avoidance of injury to the arm in dealing with their vaccinated children; and could give timely warning of the danger of sanitary defects or of exposure to infection from the specific fevers. Many accidental complications might thus be avoided.

Summary.—To secure successful vaccination, cleanliness, in the surgical sense, the careful selection of lymph from healthy children whose antecedents are known if humanised lymph be used, or the examination of the calf after death if calf lymph be used, and the postponement of vaccination on all feeble, cachectic children, or on those who are suffering from cutaneous eruptions, are essential. If these simple precautions be honestly carried out, the risk of invaccinated

disease, or of any complication resulting directly from vaccination, will in the great majority of cases be obviated.

Since, with few exceptions, the complications which arise are not peculiar to vaccination, it is unnecessary to speak at length about their treatment. The most important points to remember are to keep the pocks uninjured, dry, and clean. They may be dusted, if necessary, with starch and iodoform powder, or with gallate of bismuth. If ulceration occur it may be necessary to make some stimulating application to the wound, such as solution of chloride of zinc (gr. 10 to 40 to the ounce), or solution of hypochlorite of soda; but as a rule careful washing with warm water, or with a solution of boracic acid (gr. 20 to the ounce), will suffice without any more powerful application.

The treatment of such complications as syphilis, erysipelas, glandular abscess, eczema, impetigo, do not call for special comment. There is nothing in them peculiar to vaccination, and they may be treated without reference to the foregoing operation, provided only that the pocks themselves be kept free from injury, and in a healthy state. Lastly, it is above all things necessary that the child's general health should be attended to, and that it should not be vaccinated immediately after weaning, or after any other important change has been made in the method of feeding. There is a general disposition to regard vaccination as so trivial an operation that no precautions are necessary to ensure the well-being of the child, and to forget that the local pock is but the expression of a constitutional disturbance affecting a change in the whole being of the individual under operation.

T. D. Acland.

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The Final Report of the Royal Commission on Vaccination (London, Eyre and Spottiswoode, 1896) contains an invaluable summary of the history of vaccination and of the evidence laid before the Commission. A volume containing this report, and much information concerning vaccinal complications, will shortly be issued by the New Sydenham Society (Lewis and Co.)

T. D. A.